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AMERICAN RAILWAY JOURNAL.

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LARGE LOCOMOTIVES FOR THE SOUDAN RAILway, in Egypt, have been built by Neilson & Co., of Glasgow, Scotland, in consequence of the British advance into lower Egypt. They are of the twelve-wheel type, with outside inclined cylinders, and long extension smokeboxes. The tenders are carried on two four-wheel trucks with plate frames, and having inverted semi-elliptical springs resting on hangers resting on top of the axle boxes. The railway is of 3 ft. 6 ins. gage, and the engines are identical with some built at the same works for the Cape Government Railway, of South Africa, to operate the new Bechuanaland Railway. They are designed to haul a train load of 206 tons up a grade of 2½%, 7 miles long, with curves of 462 ft. radius, at 6½ miles per hour. The leading dimensions and particulars are as follows:

Driving wheels (8)	3 ft. 6¼ ins.
Truck wheels (4)	2 " 4 "
Tender wheels (8)	2 " 9½ "
Wheelbase, driving	12 " 0 "
" engine	21 " 3½ "
Length over engine and tender	53 " 7 "
Weight on driving wheels	72,000 lbs.
" of engine	93,400 "
" of tender, loaded	68,000 "
" of tender, light	35,200 "
Cylinders	7 × 23 ins.
Boiler (straight top), diameter	4 ft. 5⅛ "
Boiler pressure	160 lbs.
Firebox (copper), length	8 ft. 6 ins.
Grate area	17.5 sq. ft.
Tubes (brass), number	185
" diameter	1⅞ ins.
" length between tube plates	10 ft. 9 "
Heating surface, tubes	976 sq. ft.
" " firebox	102 " "
" " total	1,078 " "
Exhaust nozzle, diameter	4¼ ins.
Smokestack, diameter; top, 1 ft. 5 ins.; bottom 1 ft. 1¾	"
" height from rail to top	12 ft. 10 "
Capacity of tender tank	2,600 gallons
Capacity of tender coal space	11,200 lbs.

A FAST RUN on the Union Pacific Ry. was made between Evanstown, Wyo., and Omaha, Neb., Aug. 4 and 5. The run of 955 miles was made in 24 hours, including stops, or at the rate of 40 miles per hour. The distance of 291 miles from North Platte to Omaha was made in 279 minutes, or at the rate of 63½ miles per hour. The train was a special, and it is said that it was hauled the entire distance by one engine, which was built at the railway company's shops at Omaha.

THE STREET RAILWAY SYSTEM OF GLASGOW is now entirely under the control of the municipality, the city recently having leased lines not already acquired. About 99,000,000 passengers were carried during the year ended May 31, 1897. Had the rates prevailed during the year that were charged there years before the city assumed control of the lines the total fares paid during 1896-7 would have been more than $800,000 in excess of those actially paid. Notwithstanding this reduction in fare the city increased both the service and the wages of all classes of employes, paid interest and 2% to the sinking fund, over $40,000 to the "Common Good," some $60,000 depreciation, $70,000 to the permanent way renewal fund and placed nearly $100,000 in the general reserve fund. The last two funds now amount to over $350,000. The total receipts for the year were $1,780,000 from traffic and $25,000 from other sources, and the working expenses alone were $1,395,000.

PROPOSALS FOR ELECTRIC LIGHTING for the streets and municipal buildings of Port Elizabeth, Cape Colony, South Africa, will be received until Sept. 21 by Davis & Soper, 54 St. Mary-Axe, London, England, from whom information may be obtained. The proposals are to be for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years, respectively. The number of inhabitants is about 30,000, of whom about 20,000 are Europeans. There are approximately about 54 miles of streets in the town as follows: Main thoroughfare, 5 miles; principal streets, 17 miles; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16 c. p. The municipal buildings consist of Town Hall, Municipal Offices, Morning Market, Feather Market, Wool Market, and Museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Mr. S. Mandy is Acting Town Clerk.

A NEW CONDUIT ELECTRIC RAILWAY SYSTEM was recently tested in Hamburg, Germany, with results which seem to warrant further experiments and in some respects indicate a possible solution of the at present doubtful matter of conduit railways. In conduit work the great difficulty has been to maintain the conduits free from water and mud which invariably, sooner or later, causes breakdowns of insulation or else short circuits the conductor rails. The method adopted in the system mentioned to overcome this defect is a modification of the principle of the diving bell, the bell in this case being a long inverted U-shaped metal trough. This is made in sections of a convenient length, depending upon grade and other conditions, with the conductor held in the bend of the U by some substantial insulating material. The ends of these sections are provided with an inclined insulated block intended to throw the contact brush from one section to another without shock or jumping. Each car has three current-taking arms arranged to reach down into the slot and up around the edge of the inverted trough into the air chamber where the conductor is placed. The spacing of these arms and the length of the trough sections are such that one or two brushes remain always in contact. Should the conduit become filled with water the conductor remains perfectly dry because the air in the trough cannot escape, and consequently holds the water away from the conductor. During the tests made in Hamburg on a section of track 525 ft. long, which had been constructed several months previous, a leakage of from 0.2 to 0.3 ampere was noticed with the conduit completely flooded. This increased to over an ampere when a car was run over the track, but by the time the other end was reached the leakage current had dropped to about 0.45 amperes as a result of the electrolysis of the small quantity of water splashed up by the contact brushes of the moving car. The construction of such a conduit is stated to be very cheap. It has been called to our attention that practically the same system is covered quite completely in principle and detail by patent No. 476,776, issued by the U. S. Patent Office, June 14, 1892, to R. W. Barkley, of Brooklyn, N. Y.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the New York, Chicago & St. Louis Ry., Aug. 4, about a mile east of Silver Creek, N. Y. The accident resulted from the breaking of an axle of a car in the centre of an east-bound freight train. Three tramps are reported killed.

AN EXPLOSION resulting in the death of seven persons and the serious injury of a number of others occurred in Chicago, Aug. 5, during the burning of a grain elevator. The exact cause of the accident is not known, but it is credited to either a boiler's bursting or the explosion of "mill dust."

AN ACCIDENT to the Welland Canal is reported as the result of the steamer "Britannic" running into Lock No. 6. Four gates were carried away, and navigation will be stopped until repairs can be made.

THE STOPPAGE OF A TRAIN BY HAILSTONES is reported from Ottumwa, Iowa, on Aug. 3. The Rock Island passenger train encountered a violent storm, and the press accounts have it that the hailstones accumulated in such quantity and of such size in a cut that the train had to be stopped. Every window in the train was broken.

A SERIOUS FIRE occurred in Chicago, Aug. 5, and destroyed the Northwestern elevator of the Chicago Railway Terminal Elevator Co., besides damaging surrounding property. During the fire an explosion of the inflammable dust blew out both sides of the building, the wreckage killing five firemen and a spectator, while nearly 50 persons were badly hurt and it is expected that some of the injured firemen will die. The loss will aggregate about $400,000. It is said that the fire is the worst that has occurred in Chicago since the burning of the Cold Storage Building at the Columbian Exhibition in 1893.

PROPOSALS FOR NEW YORK STATE CANAL WORK will be received by George W. Aldridge, Superintendent of Public Works, in Albany, N. Y., Aug. 24, 12 o'clock noon, for work on the Eastern and Middle Divisions, and to Sept. 3 for work on the Western Division. In all 26 contracts are to be let, each covering from a fraction of a mile to 8⅛ miles in length. Five per cent. of the amount of proposal must be deposited with bid and this will be retained as part of the security for the faithful performance of the work. The amount of labor bond required on execution of the contract will be 40% of the proposal, and 45% will be required in the bond for faithful performance of the contract.

THE SEATTLE AND LAKE WASHINGTON WATERway Company, reported in our issue of July 15 as suspending work, asks that we make the following corrections in that connection: Mr. Eugene Semple, the President of this company, says that his company does not owe the Bowers Dredging Co. $50,000, as reported in the Portland press, or any amount, at this time. The Seattle & Lake Washington Co. is in good condition and shortly expects to resume work on the enterprise in its charge. The difficulties of the Bowers Dredging Co. are reported as being only temporary, with a maximum of indebtedness not exceeding one-third of its visible assets at Seattle alone. It also expects shortly to resume work on the Seattle waterways.

THE MAPS FOR THE LAKE ERIE-OHIO SHIP-CANAL project are to be made in New York. The contract calls for two maps; an engineering map 16½ by 72 ins., showing the engineering and topographical features of the route, and a commercial map, 26 × 32 ins., giving the entire water system effected by the proposed canal, from the Mississippi River to the Lakes and Norfolk, Va. These maps will form part of the forthcoming printed report of 250 pages, of which 5,000 copies will be printed.

THE LACHINE RAPIDS HYDRAULIC & LAND COMPANY started its machinery on Aug. 2, for supplying electrical power to Montreal. These works were fully described and illustrated in our issue of Feb. 18, 1897.

THE GOVERNMENT ARMOR BOARD, appointed by order of Congress to consider and report upon the construction of an armor-making plant by the government, is constituted as follows: Commodore J. A. Howell, Captain A. H. M. Cormick, Chief Engineer G. H. Perry, Civil Engineer A. G. Menocal, Lieutenant F. F. Fletcher and Lieutenant W. I. Chambers; all of the United States Navy.

BIDS FOR THE COLLECTION AND DISPOSAL of garbage and ashes are to be received in Minneapolis on Aug. 27 and in Chicago on Sept. 3, as stated in more detail in our advertising columns.

THE HUDSON RIVER TUNNEL PROJECT is again being discussed. According to Lord, Day & Lord, the legal firm in charge of the interests of the English bondholders, an effort would soon be made to foreclose the mortgage on the property, reorganize the company and complete the tunnel. Mr. Charles M. Jacobs, C. E., of New York, has been appointed to examine the work and report to the bondholders' committee. This tunnel was commenced in 1874, and when work was suspended in 1892 about $4,000,000 had been spent and the tunnel extended 3,916 ft. east from the Jersey City shaft, and 170 ft. west from the shaft at the foot of Christopher Street. The total distance between the two shafts is 5,400 ft. It is estimated that about $1,000,000 more will finish the tunnel.

A SPRINKLING CART EQUIPPED with a gasoline engine and a rotary pump is reported as having been ordered by the county supervisors for sprinkling streets in the fruit-growing section about Visalia, Cal. The pump would be used to fill the cart from irrigating canals or wells.

PILES 103 FT. LONG will be required for the foundation of the new post office in Chicago. According to the borings reported in the Chicago press the rock lies at that distance below the surface and the overlying material is very soft mud. Gen. William Sooy Smith is the consulting engineer and he says piles will be tried, and if for any reason these should be found unsuitable columns filled with concrete will be sunk to bed rock.

EIGHT GAS COMPANIES IN CHICAGO have consolidated under the name of one of the original companies, the People's Gas Light & Coke Co. The consolidation is the culmination of an attempt begun some ten years ago to unite all the companies of Chicago. The famous Chicago Gas Trust was formed, but a few years ago it was forced to disband, after a hot legal fight. The last session of the Illinois legislature authorized the present consolidation. The capital stock of the new organization is $25,000,000. Mr. C. K. G. Billings is President and Mr. L. A. Wiley is Secretary and Treasurer of the new company. Three recently formed companies are not included in the combination, but it is said that a division of territory has been effected.

SEWAGE FILTER BEDS AT PARIS, TEX.

The first city in the South to put in a sewage purification plant is Paris, Tex. This city has just completed about five acres of filter beds under the direction of Mr. Walter C. Dean, City Engineer, to whom we are indebted for information regarding the plant.

Paris is located in the northeastern part of Texas, about 14 miles south of the Red River, at an elevation of 588.3 ft. above the sea. Its population increased from 3,980 in 1880 to 8,254 in 1890, and is now placed by Mr. Dean at 15,000. Water-works were built in 1888 by the city, and a company, jointly, but are now owned wholly by the city.

In the spring of 1894 the city granted a one-year franchise for a partial sewerage system to Mr. N. H. Ragland, a resident of the city. Mr. Ragland agreed to construct 2,700 ft. of 12-in., 3,200 ft. of 10, and 10,300 ft. of 8-in. sewer, or a total of about three miles, providing the city would build 3,600 ft. of 16-in. sewer (probably the outlet). It was further agreed that Mr. Ragland would turn his sewers over to the city at the end of his one-year franchise, which he did. He recouped himself by charging a certain sum (not stated) for each private water-closet connected with the sewers, and $2,400 for connecting the Lamar Co. jail and court house. Since the city came into control of the plant it has charged $50 for each private connection made. Under both private and public ownership the connection fee has been in lieu of all future rent. The city got the sewers built by Mr. Ragland without cost, except the franchise; and the $50 connecting fee which it has since charged has met the cost of extensions. At present there are about seven miles of sewers in use, serving the entire southern and western parts of the city, which are the most thickly settled sections. On July 1, 1897, there were 236 buildings, containing 387 water-closets, connected with the sewers.

There are no perennial streams in or near the city, but there are two creeks, one at the east of the city and another at the west. The latter is known as Baker Creek, and empties into the Sulphur River about 18 miles south of Paris. This stream carries the main portion of the surface drainage from the city.

The sewers originally discharged through an outlet into Baker Creek. After so discharging for one summer the farmers below began to sue the city for damages, the combined claims amounting to $15,000. The only suit yet tried resulted in an award of $900 to a farmer four miles below the city, who claimed $2,500 damages. The case has been appealed and the other plaintiffs are awaiting results.

Fig. 1.—Plan of Sewage Filter Beds at Paris, Tex. Walter C. Dean, City Engineer.

These suits brought up the question of some other means of disposal. In January, 1897, Mr. Dean made surveys and located the present filter beds, which were put under construction on Feb. 26, 1897, and completed June 17, 1897, delays having been caused by continued rainy weather.

The city bought ten acres of land at $75 an acre. Of this, 5½ acres is laid out in beds and embankments, one acre lies across the creek, and 3½ acres is reserved, as shown in the plan, Fig. 1. The beds are located ½ mile southwest from the city limits, or 2½ miles from the public plaza. The main outfall sewer is two miles long, and has a fall of 94 ft. from the public plaza.

The 18-in. outfall sewer ends in a small receiving pit, from which extend two small settling and screening basins, as shown on the plan. The pit and the basins are built of concrete and brick.

FIG. 2.—VIEW OF RECEIVING PIT AND SETTLING BASINS AT PARIS, TEX., WITH FILTER BEDS IN BACKGROUND.

The basins are each 25 ft. long, 10 ft. wide for the first 2 ft. in depth from the top; from which point they slope 3½ ft. to 4, making the bottom width 3 ft. The total depth is 6 ft., giving 4 ft. of sewage below the water line of the outlet. The sludge from the basins, only a small amount of which is expected, will be pumped out and spread over the 3½ acres not laid out in beds and plowed under.

The settling basins are provided with screens for matter coming from the receiving pit to fall upon, and also with 1-16-in. screens at the outlet from basins. Mr. Dean states that not the smallest particles of solid matter (only the smallest?) get from the basins on to the beds, the basins catching all solid matter of appreciable size. He also states that the filter beds show no signs of sludge deposits, that the carrier ditches are clean, and that the effluent gets better every day, being as clear as crystal and without any odor whatever.

The banks between the beds are 2½ ft. high, with a width of 2 ft. at the top and 6 ft. at the base, the carrier ditches extending along the banks.

Beds Nos. 7, 17 and 21, or those next to the creek, are constructed entirely of sand. All the other beds have 18 ins. of sand at the top and 2½ ft. of clay below, but the underdrain ditches here were back-filled with sand, the clay being used for the embankments.

Underdrains of 4-in. tile are laid across the beds as shown, 13 ft. c. to c., except at each lateral carrier ditch, where the drains are 10 ft. c. to c., or 5 ft. each side of the ditches. The tops of the drains are 4 ft. below the surface of the beds and carrier ditches, and terminate 18 ins. above the level of water in the creek. The total length of the underdrains laid is 20,179 ft., or an average of 385 ft. to each ditch. The banks around the ends of the underdrains at the creek are protected with Bermuda grass, which Mr. Dean states it is impossible to wash out after it has once obtained firm root. This grass is also grown about the receiving pit and settling basins, as is shown in Fig. 2.

The total cost of constructing the filter beds and all the accessories described was $3,730, and the land cost $750 in addition. This is exclusive of engineering and inspection, which cost $750 extra, making a total cost of $4,480, without the land, and $5,250 with it. It was necessary to extend the outfall sewer to reach the disposal area, and the 4,100 ft. of 18-in. pipe required for this purpose cost $3,312, including engineering and inspection. No bonds were issued for any part of the works, the cost being met by the revenue from sewer connections and from the current funds of the city.

The amount of sewage being delivered to the beds early in July, 1897, was from 35,000 to 40,000 gallons per day. Sewage is applied to each bed for about twelve hours at a time. It is proposed to raise alfalfa on the beds next year, but no attempt at crops is being made this year. At present the beds are being cared for by one man, who receives as wages $35 per month.

The plant bids fair to be a great improvement over the previous method of disposal, which it is easy to see must have been highly objectionable in summer, when hot weather, combined with no dilution of the sewage, must have given rise to great offence. The filling of the underdrain trenches with sand, where through clay, is to be commended. Of course, there still remains but 18 ins. of filtering material, except over the underdrains, but the underdrains are so near together that the sand-filled trenches make up quite a percentage of the beds, and from the shallow filtering material over the balance of the area considerable lateral filtration must take place before the effluent can reach the underdrains.

STRUCTURES ON THE TRANS-SIBERIAN RAILWAY.

(With two-page plate.)

We have received from a correspondent at Tomsk, Central Siberia, a series of photographs of structures along the line of the Siberian Railway, the set being originally prepared for the use of the Russian Ministry of Roads and Bridges, at St. Petersburg. For these our correspondent acknowledges his indebtedness to the courtesy of M. Pruchkol, engineer at Tomsk.

We have selected some of these views for reproduction as showing the substantial character of the work performed on this railway by the Russian government. The bridge over the Tomsk River, Figs. 1, 2, 3, 4, one of the most important engineering works on the line, has six spans of 280 ft. each, with a total length of 2,240 ft., including the approaches. The piers for this bridge were founded by the use of compressed air and are massive in outline and provided with unusually heavy ice-breakers, made necessary by the thick ice which forms on that river in the far North. Upon the completion of the piers, unusually heavy falseworks were put in place between them and possi-

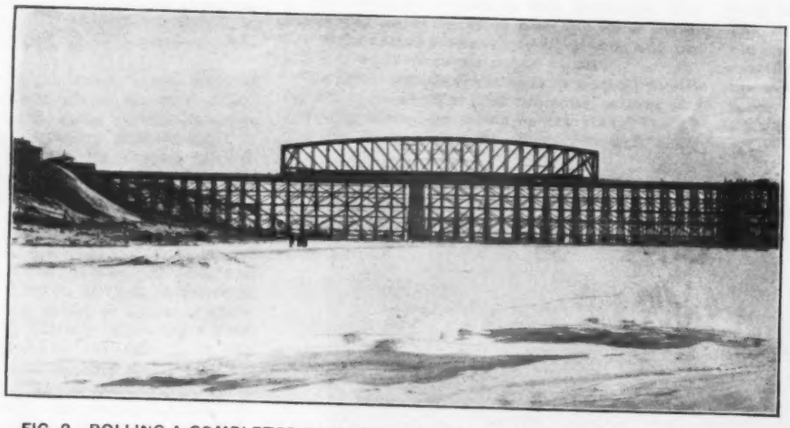


FIG. 2. ROLLING A COMPLETED SPAN OF THE TOMSK RIVER BRIDGE INTO POSITION.

FIG. 1. BRIDGE ... THE T...

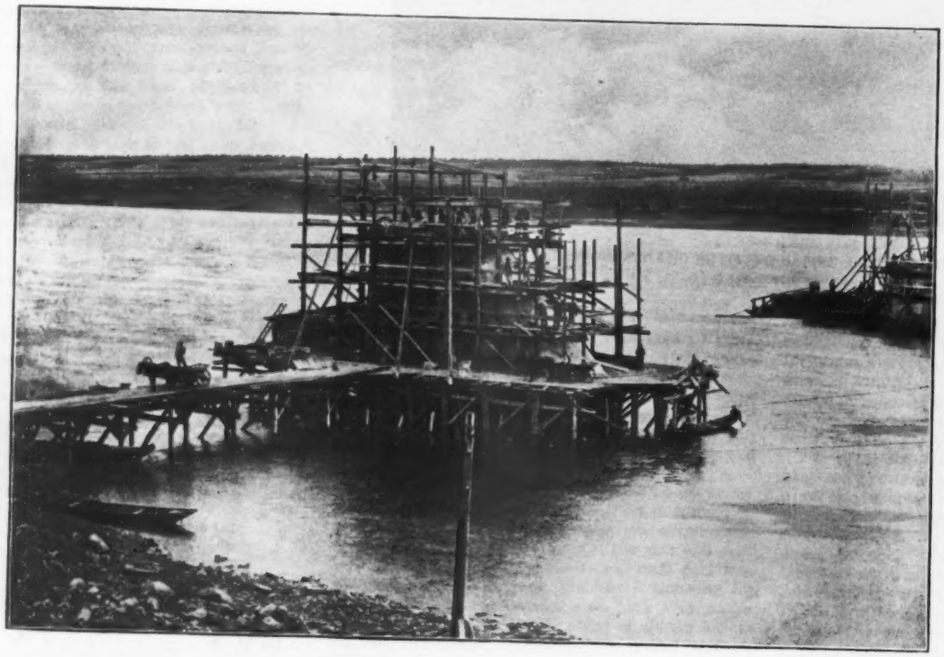


FIG. 4. BUILDING A PIER OF THE TOMSK RIVER BRIDGE.

FIG. 7. RO... TIMBE...

FIG. 8. A TWIN CULVERT UNDER A HIGH EMBANKMENT.

FI...6. TEM...

VIEWS ON THE TR...S-SIB...

RIDGE THE TOMSK RIVER.

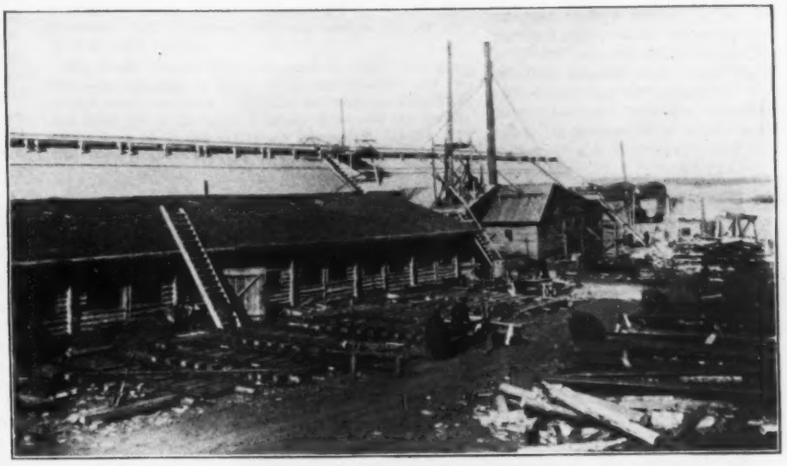
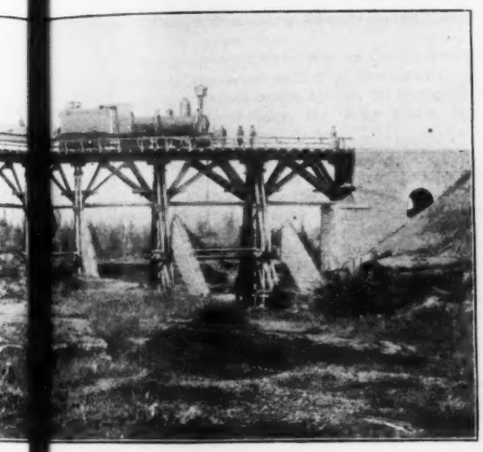


FIG. 3. WORKSHOPS AT TOMSK RIVER BRIDGE WHERE THE SPANS WERE ASSEMBLED.



7. RO TIMBER TEMPORARY TRESTLE.

FIG. 5. A SPECIMEN BRIDGE OF MEDIUM SPAN.

6. TEMPORARY HOWE TRUSS BRIDGE.

FIG. 9. LOCOMOTIVE OF A CONSTRUCTION TRAIN.

TRANS-SIBERIAN RAILWAY.

bly were used for the passage of construction trains before the iron-work of the bridge was ready for erection. This was done with many of the smaller structures, as is shown by the views received; excellent masonry abutments being built, with bridge-seats and other details complete, and the opening then filled with round timber trestle-bents providing a roadway for trains until the metal bridge could be received and erected. At the Tomsk bridge the spans were evidently assembled on the shore and then rolled out into position bodily, as shown in Fig. 2. Fig. 3 shows the erecting shops at this point, with some of the members in the foreground, as received from the mills in Russia and Germany.

Figs. 5 and 6 show two of the smaller bridges; one an excellent iron or steel structure, and the other a wooden Howe truss crossing one of the marshes frequently found throughout Central Siberia. Fig. 7 is one of the cases where a temporary trestle structure of round logs has been erected for the purpose of passing the construction trains. In this case separate ice-breakers of logs have been built to protect the trestles in case of flood. Figs. 8 and 9, as well as Fig. 7, show the excellent quality of the masonry structures on the Siberian railway; and Fig. 9 also gives a very good idea of the locomotive and cars used at present.

From these and previous photographic views presented it is evident that a first-class railway is being built through Siberia, and provisions are being made, so far as these structures are concerned, for a fast service almost as soon as the road can be opened for operation.

The most recent statement of the progress made to date in the construction of this railway is contained in a report made by the U. S. Consul-General at St. Petersburg, Mr. John Karel, the substance of which is as follows:

The committee which manages the construction of the Great Siberian Railway has reported to the Czar the work done on said road during the year 1896. The committee found it practicable during the year to fix the definite cost of the construction of the Northern Ussuri line at 21,709,930 rubles ($11,158,904), the second section of the Central Siberian line at 50,197,977 rubles ($25,801,760), and the branch line to the city of Tomsk at 1,830,765 rubles ($941,013). The cost of the rolling stock of the Transbaikal road was determined at 6,643,395 rubles ($3,414,705), and that of the Perm-Kottlass road at 3,496,095 rubles ($1,796,993). The estimates for the construction of the two last-named lines were not ready to be submitted to the committee, owing to the difficulties in finding a route combining economy and ease of construction. The latter was finally obtained and approved only at the end of the year. The said road will run, with little variation, through the valley of the River Cheptsy toward the town of Glazov, and the committee has recommended that the work be continued in the most economical method. In order not to interrupt the course of construction of the Transbaikal and the Perm-Kottlass lines, the committee decided to grant sufficient means to continuue the work during the summer of 1896 on the sections of the above-named lines on which there were to be no changes.

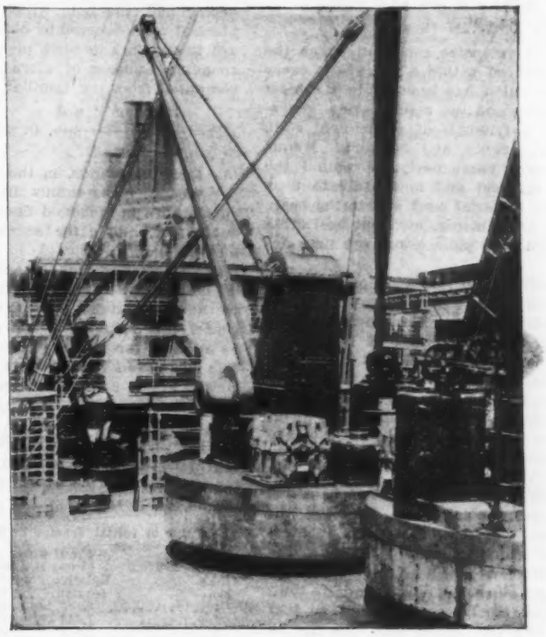
The committee, wishing to build the terminus of the Siberian Railway on the Pacific Ocean in a suitable manner, since this point will play a significant part in future transit over the great road, has chosen the bay of Gold Horn for the establishment of a commercial port. The committee has selected and prepared a prominent strip near the shore for an elevated harbor wharf, thinking that in case future commerce should develop to a great extent, the requirements could be satisfied by constructing a supplementary section of the port in some of the waters near Vladivostok. It has been decided to build the port gradually, according to the development of commercial requirements, and in a way to protect at the same time the interests of the Russian war fleet (with all possible additions thereto), which will have, as heretofore, anchorage in the bay of Gold Horn.

The Russo-Chinese Bank, established a year ago for the purpose of developing commercial relations between Russia and China, obtained, in 1896, from the Chinese Government a permit for the construction of a railway line through Manchuria, and a special stock company was organized for that purpose. When this great enterprise is realized, the necessity of constructing the Amur section, which presents such technical difficulties, will disappear, and it will be only necessary to build a branch line about 530 versts (351 miles) in length from the Transbaikal and Ussuri lines to the Chinese border, and thus the distance for the transit of goods will be approximately shortened 514 versts (341 miles).

During the year 1896, the committee found it necessary to increase the number of employees and the appropriation for the administration of the Siberian Railway, so that the steadily increasing work could be properly executed. The Ekaterinburg and Cheliabinsk division, a branch line of the Western Siberian Railway, is completed, and the exploitation of the same has shown that in the near future it will be necessary to increase its transport facilities, since the requirements already exceed all expectations.

The South Ussuri line, completed in 1895, was considerably damaged by heavy rains last summer, and requires much repairing. The Central Siberian line from the River Obi to the town of Krasnojarsk and the branch to the town of Tomsk are nearly completed. On the section from Kransnojarsk to Irkutsk, rails have been laid 25% of the distance; on the Northern Ussuri line, 69%; on the Perm-Kottlass line, 4%; and on the Transbaikal, 8 versts (5⅓ miles). Thus the whole length of rails already laid, excluding stations and side tracks, amounts to 3,412 versts (2,262 miles).

The principal work accomplished in 1896 was the making of the roadbed, of which 2,464,200 cubic sageni (31,305,197 cubic yards) have been worked, and the ballasting of more than 1,324 versts (878 miles) in length of the railway. Besides the work on the railway, work was commenced for establishing a steam passage over Lake Baikal, which is expected to be ready in 1898, i. e., when the Siberian Railway will probably be completed from Krasnojarsk to Irkutsk. For the construction of all the above lines of the Siberian Railway 73,998,810 rubles ($38,045,388) have been appropriated.



VIEW OF PORTION OF DECK OF THE STEAMSHIP "BREMEN," SHOWING ELECTRIC CRANES FOR HANDLING BAGGAGE.

ELECTRIC CRANES FOR HANDLING BAGGAGE ON THE NORTH GERMAN LLOYD STEAMER "BREMEN."

The substitution of electric power in place of the usual donkey steam engines used for handling freight and baggage on ocean passenger steamers seems to promise several advantages which are likely to lead to its extended use in the future. Already the North German Lloyd Steamship Co. has adopted this power in the place of steam for handling freight on three of its trans-Atlantic steamers, the "Darmstadt," "Prinz Heinrich" and "Bremen." On the two vessels first named, winches operated by electric power were substituted for the usual donkey engines, and they proved so successful that the "Bremen" was provided with a full equipment of electric power cranes. The contractors for these three power plants were the Union Electricitats Gesellshaft, of Berlin, Germany, which is the German ally of the General Electric Co., of Schenectady, N. Y.

The accompanying cut gives a general idea of the electric cranes used on the steamer "Bremen." Altogether 16 cranes are used, eight on each side of the vessel. Four of these cranes have a capacity of 6,614 lbs. each, and 12 a capacity of 3,307 lbs. each. The outboard swing of each crane is 20 ft. 6 ins. Each crane, with its motor and controlling mechanism, is mounted upon a circular iron platform, which revolves upon a pivot. A circular rack is bolted to the deck, with which a vertical pinion shaft, operated by the motor on the platform, meshes and revolves the crane after the familiar manner of a swing bridge turntable. The motor used for turning is of 7 HP. capacity at 700 revolutions per minute, and operates the vertical shaft by means of a worm gearing. A separate motor of the series type and 25 HP. capacity at 900 revolutions operates a shaft connected by worm gearing with the hoisting drum of the crane. On the gear end of the drum shaft is also fitted a winch head. The equipment described is the same for every crane, except that the hoisting speed of the four larger cranes is 60 ft. per minute at full load, or only one-half the speed of the smaller cranes. The speed of the jib of each crane is 13 ft. per second.

The controllers for operating the cranes are mounted on the revolving platform, and resemble two ordinary series parallel street car controllers fastened back to back. Gears are placed on the projecting studs instead of the usual levers, and sector gears mesh into these. The single operating lever is connected to the sections by a form of universal joint in such a manner that an upward movement starts the winding motor and raises the load and a downward motion causes the load to be lowered. Likewise a swing to the right or left results from a movement of the lever in a corresponding direction. By moving the handle upward along a diagonal the load can be lifted and swung at the same time. To insure a complete control of the crane foot brakes are provided.

In placing the cranes the following requirements had to be met: The load must be lifted smoothly at any desired speed up to the maximum; stops and starts must be rapid, but smooth and free from jerks; the crane must be compact and contain as few parts as possible; all parts liable to injury must be protected from the elements and must be able to stand severe treatment; the controlling mechanism must be simple, reliable, and of such a nature as to admit of operation by ordinary dock hands. It was also specified that the working of the cranes should be noiseless, to meet the demands of the passengers' comfort.

The power generating plant is located in the after portion of the engine room, and consists of

four dynamos, each directly connected to its own engine. Two of these are placed on the starboard side and two on the port side. The dynamos have each a capacity of 75 K-W., or 100 HP., when running at a speed of 210 revolutions per minute. At this speed they generate 105 volts. The output of two dynamos is used for the cranes; one is used for the lighting of the ship, and the fourth dynamo is held in reserve in case of accident or other emergency. The engines are of the triple expansion type, and were built by Schichau, of Elbing, near Danzig.

TENSION OF SPOKES IN BICYCLE WHEELS.

By D. W. Hering.*

In the rapid and extensive evolution which the bicycle has experienced within a few years, every item in its construction has been made a subject of study by experts, and the result is now generally regarded as a triumph of mechanical skill, combining safety, beauty and comfort. Manufacturers take pains particularly to remind the public that the severest and most delicate tests are applied to the material used and to the bearings, fastenings, adjustments, etc., not hesitating to claim perfection with more assurance than accuracy.

Opinions may differ as to just what part of a bicycle demands the highest perfection in its construction, but while conceding the importance of a good frame, and the advantages of frictionless bearings, it will hardly be denied that the wheels themselves are entitled to close attention. Notwithstanding the improvements that have been made in these, even since the adoption of pneumatic tires, there is yet a serious defect in the wheel as now constructed when considered from the engineer's point of view.

In bicycle wheels the axle with the weight which it sustains is suspended from the rim by the spokes, which are, therefore, in tension. If rotated on the axle without touching the floor, the mechanically correct wheel will be round and centered or "true," and all spokes will be equally taut. The utmost tension in any spoke would be just so much that when the wheel was bearing its load, the spoke in its most relaxed position would not be slack. It is customary to connect the rim to the hub by inserting the spokes, and then to tighten one spoke or another until the wheel runs true. As the rims are of varying diameters, the differences sometimes in wood rims amounting to 1 in. in a 28-in. wheel, this trueing-up process results in all degrees of tension in the spokes, and since the workman has no definite standard by which to be governed, the whole operation is haphazard as to the tension in the least-strained spoke. The wheel in some instances might be made just as true and yet every spoke be less drawn upon. On the other hand, the wheel may be strung up to such a pitch as to leave for the tightest spokes but little margin of safety under a heavy load or sudden jolt.

The substitution of tangent for direct radial spokes has been of advantage, by permitting a less clumsy construction with greater security of attachment at the ends. As the spokes are usually arranged, the hub is in suspension from four nearly vertical spokes in two pairs, the first pair having one spoke tangent on, say, the forward side at the right end of the hub and the adjacent spoke tangent on the other side of the hub at the left end. The other pair consists of the next spokes forward and back, the first attached to rear of hub at the right end and the last to front of hub at the left end. For example, in the Figure, Nos. 1 and 36 constitute the first-described swing or stirrup, and this is further sustained by 2 and 35; then come 5 with 4 and 6 with 3, and thus the system of suspension is distributed around the wheel, so that as the wheel travels, the load on the hub is supported by successive groups of four spokes. This general plan is modified somewhat by different makers, the spokes being sometimes tied together where they cross. In at least one other instance the makers claim an advantage in the way of spokes which cross frequently are interwoven.

To determine just what initial tensions exist in new wheels supposed by their makers to be ready for riders, as well as to compare those of different companies, an examination was made of each wheel on five different bicycles, or ten wheels in all. The bicycles were all said to be "high-grade," four being listed at one hundred dollars each or more. They were 28-in. wheels with wood rims and with tangent spokes, including those bent or hooked at the hub, and those straight. The number of spokes to the wheel ranged from 28 to 40, the rear wheel in every case having from 4 to 8 spokes more than the front one. The spokes ranged in diameter from .058-in. to .07-in. The length, diameter and density of the spoke being determined, the note which it sounded on being plucked was observed by comparison with a standard tuning fork or pitch pipe, and from the corresponding number of vibrations the tension was computed from the familiar formula of physics.

$$P = \frac{n^2\,(2r)^2\,l^2\,\pi\,d}{g},$$ in which P is the stretching force in pounds, n, the number of vibrations per second, r the radius and l the length of the spoke, both in inches, d the density in pounds per cubic foot, and g the acceleration of gravity in inch-seconds.

The suggestion that the spokes of a wheel should all be brought to the same tension by tuning them to the same pitch has been made, perhaps, many times. Such tuning would only replace one evil by another, for then the wheel would not be round. The purpose of this paper is to show what irregularities are to be met with in the best wheels.

The machines that were examined may be designated as A, B, C, D and E, and the figure representing the rear wheel of model E, together with the appended table, will serve as an illustration for all, although the actual values are different in the different cases.

Table of Initial Tension of Spokes in Bicycle E.

Spoke No.	Front wheel.—Relative tension.	Front wheel.—Actual tension in lbs.	Rear wheel.—Relative tension.	Rear wheel.—Actual tension in lbs.
1	1.	69	1.414	113
2	1.414	97	2.52	202
3	1.414	97	1.26	101
4	1.78	123	1.59	127
5	1.78	123	2.25	180
6	2.	138	2.	160
7	1.78	123	1.59	127
8	1.78	123	2.	160
9	1.26	87	2.25	180
10	1.78	123	1.59	127
11	2.	138	2.	160
12	1.59	110	2.	160
13	1.59	110	1.59	127
14	1.59	110	1.41	113
15	1.59	110	2.	160
16	2.	138	2.	160
17	1.59	110	1.41	113
18	1.26	87	2.	160
19	1.59	110	1.78	143
20	1.59	110	1.41	113
21	1.26	87	2.	160
22	1.78	123	1.41	113
23	1.41	97	1.41	113
24	1.41	97	2.	160
25	2.	138	2.	160
26	2.	138	1.22	90
27	1.59	110	2.	160
28	1.59	110	1.41	113
29	....	...	1.59	127
30	....	...	2.	160
31	....	...	1.26	101
32	....	...	2.25	180
33	....	...	1.78	143
34	....	...	1.	80
35	....	...	2.25	180
36	....	...	1.41	113

Besides the range and variety of tensions which the table shows, it is also interesting for showing the comparison of tension in spokes adjacent to one another, and in any four comprising one suspension group. Great and unexpected differences are seen as where No. 34, with 80 lbs. pull, is followed by No. 35, with 180 lbs.

Table of Greatest and Smallest Initial Stresses.

Bicycle.	Tension.—Least, lbs.	Tension.—Greatest, lbs.
A Front wheel	88	156
Rear "	78	156
B Front "	92	175
Rear "	61	109
C Front "	75	150
Rear "	62	139
D Front "	108	216
Rear "	65	165
E Front "	69	138
Rear "	80	202

Model B showed greatest uniformity and least range of stress, it being the only one of the five in which there was not a difference of 100% between extremes. Samples of the spokes used in B, C, and E were tested as to their ultimate strength with the following results:

	Sectional area, sq. in.	Max. load before breaking.—lbs.	Lbs. per sq. in.
B First specimen	0.00288	535	185,800
Second "	.00288	550	191,000
C First "	.00285	575	201,750
Second "	.00285	465	163,200
E First "	.00386	455	117,900
Second "	.00386	455	117,900

It thus appears that the stress in the spokes of the unloaded wheel is not only in many cases a large fraction of the ultimate strength, but, as will be seen, is in all instances considerably larger than any stress due to the weight of the heaviest rider upon a smooth road. The distribution of weight on the bicycle, of course, depends largely upon the method of the rider, and the effort he is expending upon the pedals, but if we assume an apportionment suggested by some experts of 20% of the weight on the saddle, 60% on the pedals, and 20% on the handle bar, we shall not be excessive in our estimate of the load on the rear wheel. The

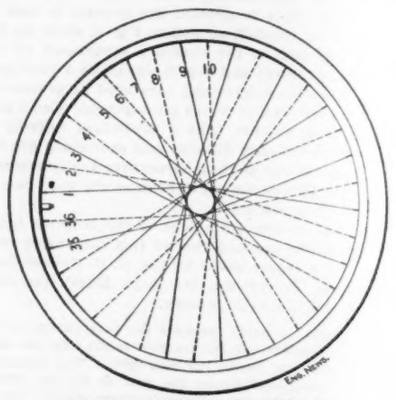


Diagram of Model E. Rear Wheel.

(Full lines represent the spokes connected to right end of hub; broken lines those connected to the left end.)

frame is about equally supported on the two wheels and the above distribution, for a rider weighing 160 lbs., added to the weight of the frame, would place about 100 lbs. on the rear axle. Dividing this equally among four spokes, the initial tension is increased by only 25 lbs. in each spoke, but this is with the load quiescent and most favorably placed. It will be seen, however, that this additional weight produces a severe trial upon the spokes when the wheel is ridden over rough places. If a weight of 25 lbs. were dropped 1 in. and caught and checked suddenly by the best spoke in the above tests, the resilience thereby occasioned in the spoke would represent a maximum pull of 512 lbs. A sheer drop of the loaded wheel through a height of 1 in. upon a solid surface would develop in the same way, if the rim and tire were rigid, a pull of 512 lbs. in each spoke in addition to the stress from the quiescent load and the initial tension. Few if any of the spokes could stand it. Of course, such an extreme case could not well arise in fact. This stress could only result if the spoke were attached to an unyielding support. The effect is mitigated somewhat by an elastic resilience of the rim, but most especially by the tire. That is the great merit of the pneumatic tire. Just how far flexibility is desirable in the rim may be questionable; undoubtedly it is in the tire that the qualities of a cushion are looked for, but if the tire is pumped "hard," a ride over rough pavements or a car track will surely give to the spokes an appreciable if indeterminate share of additional stress. If the tire is soft enough to permit the rim to strike an obstruction, the effect is worse than with the hard tire. If flexibility of the rim is desired, then there should be but few spokes, three groups or twelve in all being better than a larger number, but if the rim is to be rigid, a large number of spokes is better, and this in turn would secure greater uniformity of initial tension. Recognizing that the elastic resilience of the rim or the tire or of both is the safeguard of the spoke under a severe jar, there is still an indeterminate element in riding that intensifies the strain in the spokes. That is the possibility of

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such a succession of jars as to fall in with the stress in the spoke periodically, like the rhythmic occurrence of small vibrations which after a few repetitions may become serious even in strong structures. Any such synchronizing in the case of the bicycle could continue for a very short time at most, but a very few jars succeeding at proper intervals would make the strain serious. The softness of the wood must be of further service, although in so far as the inequality of tension is relieved by the spoke caps sinking into the wood, in so far the wheel becomes distorted, and it must then be trued up again, in which process the old fault may be renewed and perhaps aggravated.

The initial tensions as tabulated above seem great, and they are probably needlessly so, but the last turn of the screw may be responsible for the most of the excess, for after all the spokes are taut, a very little further screwing up of any one means a large additional strain upon it—how large is scarcely appreciated by the ordinary repairman, who is generally not very discriminating. If the rim were unyielding (and the tighter the wheel is strung, the more rigid it becomes) a single turn of the screw having 56 threads to the inch would mean a pull of 66 lbs. additional upon a spoke of No. 14 wire, 11 ins. long.

Whatever may be the best remedy for the defect, it is not good engineering practice to operate any machine that is subject to vibrations or shocks, with so small a margin of safety in any of its members as is seen to exist in bicycle wheels. Rims more nearly round to begin with would make so unequal and therefore so great initial tension unnecessary. Perhaps wood rims cannot be made as true as metal ones, but an improvement in quality can doubtless be made if effort is directed to it. No matter what kind of rim is used the mechanic should not evade the responsibility for excessive tightening of the spokes on the plea that they are not tuners. A maximum tension ought to be established, beyond which they should not be allowed to go, and a rim which required more than this ought to be rejected. That would give to a rider a wheel that would remain true for a longer time than is now the case, and would be more satisfactory to him than a guaranty from the makers to replace a spoke free of charge.

TECHNICAL EDUCATION IN GERMANY.

The German Minister of Labor, M. Nyssens, recognizing that German industrial progress was mainly dependent upon the development of technical education throughout Germany, lately ordered a thorough investigation and report upon this subject, and this report has now been issued. It is a lengthy and instructive document, and the American Consul at Chemnitz urges a careful study of the methods and results there set forth upon our own merchants and manufacturers.

While the State assists in the establishment and maintenance of many of these technical or trade schools, the greater number of these institutions are the outcome of the joint efforts of associations, large manufacturing concerns and the municipalities. The State of Prussia, though not holding the lead in this direction, annually expends $600,000 in the maintenance of six special schools for the construction of machinery and instruction in bronze casting, in manufactures of steel and hardware, in navigation and in the manufacture and ornamentation of pottery, porcelain and glass. These schools are founded under the auspices of the State, and the communes defray a part of the expenditure. But the heads of large industrial establishments in Prussia have founded and support by their own subscriptions, with some aid from the State, 248 schools with over 11,000 pupils. These institutions are devoted to training pupils in the smaller industries, with a school for each trade. Thus, the painters and decorators have 32 of the schools; the shoemakers, 9; the tailors, 16; the bakers, 20; the butchers, 6; the smiths, 26, etc. Theory is united with practice and this method of teaching is largely supplanting the old apprentice system in Germany.

The City of Berlin, with a wonderfully complete system of technical education, devotes $70,000 annually to this end. Bavaria, in addition to its higher schools of architecture, commerce and art, has 45 technical schools, with 2,682 pupils. Wurtemberg is introducing new industries by sending teachers about in 120 communes; and white embroidery and the knowledge of the sewing machine is thus taught. The latter machines are sold by the State at a reduced price on condition that the purchasers show and explain them to their neighbors. Baden, with only 1,600,000 population, annually spends $180,000 for this purpose, especially in the teaching of clockmaking, cabinet-work and music, in connection with the famous industries of the Black Forest district. The Grand Duchy of Hesse, with 1,000,000 inhabitants, has nine schools for artisans, 43 for industries and 82 schools of design. Saxony is at the head of all the German States in technical education, with 111 schools of this character, including ten schools of agriculture and 40 of commerce.

In Brunn, the Chamber of Commerce has turned its weaving school into a textile high school, with the purpose of furnishing specially-trained help for the development of textile industries. This school is modeled after similar schools in Verviers, Reutlingen, Aix-la-Chapelle, Cattbus, Soran, Crefeld, Berlin, etc. Included in the course is a good general education and a knowledge of commerce. The State fits up the school with machinery, supplies and apparatus, and pays the teachers. The commune, chamber of commerce and manufacturers pay for the site and the buildings. The State proposes to devote $57,000 to teaching material, apparatus, etc., $14,400 has been subscribed by the different industries, and a mortgage of $64,800 will rest upon the enterprise, to be paid gradually, and the local people pay the interest and must finally pay the principal.

NOTES FROM THE ENGINEERING SCHOOLS.

Michigan College of Mines, Houghton, Mich.—The Michigan Mining School has had its name changed, by act of the State Legislature, to that of the Michigan College of Mines. A preliminary announcement has been issued giving the scale of fees. The matriculation fee is $10, and the annual tuition fee, $25, to residents of Michigan, and $25 for matriculation and $150 for tuition to students residing outside of Michigan. Various laboratory fees, ranging from $2 to $10, are also required of those using the laboratories.

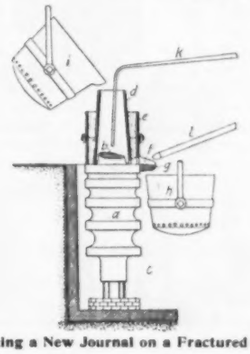
The University of Nebraska, Lincoln, Neb., issues a series of Bulletins every six weeks. Bulletin No. 3 describes the courses in the School of Mechanic Arts, giving illustrations of the equipment, etc.

Engineering School of Union University, Schenectady, N. Y.—Changes have been made in the courses in structural and sanitary engineering, in the direction of increasing the time given to the subjects of motors and motive power, mathematical theory of electricity, and engineering law and procedure. An appropriation has been made for the equipment of an electrical engineering laboratory, and the appointment of an instructor in electrical engineering and one in drafting and surveying. An arrangement has been completed between the college authorities and the General Electric Co., whose principal factory is in Schenectady, by which engineering students are admitted at regular scheduled times, under the direction of their instructors, to the company's shops and testing departments for the purpose of receiving instruction in regard to the operations carried on in the factory. The entrance requirements of the school have been gradually raised during the past two years till they now equal the requirements of schools of the first grade, as recommended by the Committee on Entrance Requirements of the Society for the Promotion of Engineering Education.

Cornell University, Ithaca, N. Y.—We have received the programme of the 29th annual commencement of the University, held on June 17, giving a list of graduates, with the titles of their theses, etc. There were 24 graduates in civil, 56 in mechanical and 69 in electrical engineering. The theses in civil engineering cover a wide range of subjects, and include designs, experimental researches, and studies in economic subjects, such as the relation of canal to railway transportation, problems in street cleaning, etc. The mechanical and electrical engineering theses show a large preponderance of those containing reports of tests of boilers, engines, power plants, electrical apparatus, etc., over those relating to designs.

AN INGENIOUS METHOD OF REPAIRING A BROKEN ROLL.

We find in one of our German exchanges, "Uhland's Maschinen Constructeur," an interesting description of a neat method of repairing a broken roll, with an illustration which we reproduce herewith. The broken roll is set vertically in a pit with its broken surface projecting a few inches above the foundry floor, and the first procedure is to build a fire of coke or charcoal around the fractured surface and bring it to as high a heat as possible. When this has been done the fire is removed, the surface is cleaned and a mold of the proper form is set over the fractured end, as shown. A ladle of molten metal containing a considerably larger quantity than is necessary to fill the mold is then brought and pouring begins. The molten iron heats the fractured surface as it falls upon it and



Casting a New Journal on a Fractured Roll.

flows away through the drain into the ladle h. This continues until the foreman by probing with the rod K finds that the fractured surface has become softened. The drain is then closed by the stopper l and the mold is filled. By this method the junction between the old and new surfaces is made so perfect that the roll is said to be as strong as when new.

THE SINTZ GAS AND GASOLINE ENGINE.

The accompanying illustrations show the general construction and operation of the standard single cylinder gasoline engine manufactured by the Sintz Gas Engine Co., of Grand Rapids, Mich. This engine is one of the few American engines which operate with a two-stroke cycle, or, in other words, receive an impulse at each forward stroke, an auxiliary reservoir being employed to aid the main cylinder and piston to accomplish the necessary exhaust and admission during a single revolution of the crank. In the illustrations Fig. 1 shows a side and end elevation of the engine, Fig. 2 is a longitudinal section of the cylinder and Fig. 3 illustrates the operation of the igniter.

To understand clearly the operation of the Sintz engine, a study of the main cylinder and piston action as shown in Fig. 2 is first necessary. The drawing shows clearly the various parts, the water jacketing, the igniter, etc. In operation the explosive mixture is admitted into the space around the crank and at the base of the cylinder. On its downward stroke the piston slightly compresses this charge, and forces it through the transfer port into the head of the cylinder, where by the upstroke of the piston it is further compressed and finally exploded by the igniter spark. It will be noted from the drawing that in its downward stroke the exhaust port is opened slightly in advance of the transfer port, and that the piston is provided with a deflector to direct the incoming gas toward the head of the cylinder and behind the exhaust gases so as to force them toward the exhaust port. Admission and exhaust are thus controlled by the piston movement alone, the engine being, in common parlance, valveless.

With the foregoing explanation of the cylinder and piston action, attention may be turned to

other essential parts, and of these the generator naturally comes first. This, as will be seen from Fig. 1, consists of a small reservoir holding about one pint of gasoline, and connected by pipe with the main gasoline storage tank. The outlet from the small reservoir is controlled by a needle valve and dial to regulate the feed to the check valve actuated by the main piston suction. The air is admitted directly below the reservoir and is taken warm from the top of the cylinder, as the location of the air pipes clearly indicate. As already said, the piston suction of the up-stroke draws the mixed air and gasoline vapor into the recess surrounding the crank, which recess is practically a continuation of the cylinder as far as this function is concerned.

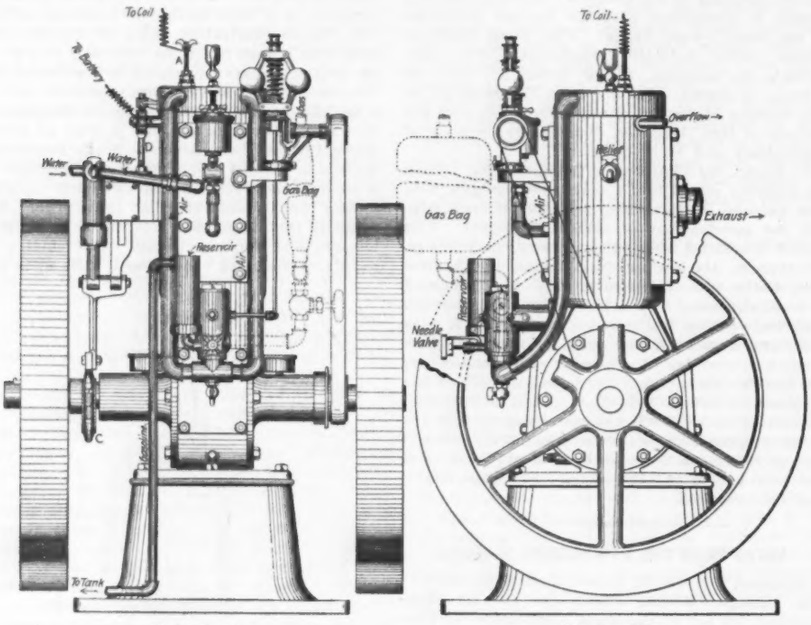


FIG. 1.—FRONT AND SIDE ELEVATIONS OF SINTZ GASOLINE ENGINE.
Sintz Gas Engine Co., Grand Rapids, Mich., Builders.

The engine is governed like a steam engine by cutting off wholly or partly the supply of gas as the speed increases above the normal for which the governor is set. The governor itself is of the familiar centrifugal ball form, operated by belt and gearing from the crank shaft, as clearly shown in Fig. 1. The expansion of the governor balls raises the governor rod, which operates by means of a crank a butterfly valve placed in the gas and air inlet tube. As the speed rises or falls from the normal, the butterfly valve contracts or enlarges the inlet passage for the explosive mixture.

As already indicated the explosive mixture is ignited in the cylinder by an electric spark. Figs. 1, 2 and 3 show the construction and operation of the igniting device. From the battery one wire runs to the screw A, Fig. 2, passing through the cylinder head, and the other wire connects with the lever B, Figs. 1 and 2. By interrupting the contact in the cylinder between the electrodes A and B, a spark is produced. The principal point needing explanation therefore is the construction and operation of the mechanism by which the interruption or break in the circuit is accurately timed and accomplished.

Referring to Fig. 1 it will be seen that the eccentric C operates the rod D, shown more in detail by Fig. 3, by means of the slide E. The rod D is guided at F and carries the projecting ring G. At H is a rod extending into the cylinder and carrying on its inner end at right angles to it the lever B, Fig. 2. At the outer end of H is a casting J, containing a clock spring. The battery wire is attached to this casting. A sleeve K serves to regulate the tension of the clock spring. At L is a steel point on the casting J. It will be understood now that the casting J can be partially revolved toward the left, winding up the spring which tends to revolve it to the right, but can do so only to a certain point on account of the block M.

In operation, the rod D, being raised by the eccentric C, engages through the projection G the steel point L and revolves the casting J toward the left. This revolution through the rod H brings the lever B inside the cylinder in contact with the bottom point of the screw A. Continuing its upward movement the rod D raises the point L until finally it slips off the projection G. Immediately the tension of the clock spring reverses the direction of the revolution of J, and thus breaks the contact between A and B, producing a spark inside of the cylinder. It will be understood that the screw A is carefully insulated from the engine.

In the foregoing the Sintz gasoline oil engine has been described, but it only requires the addition of the piping and gas bag, shown by dotted lines in Fig. 1, to enable gas to be used instead of oil. Both gas and oil engines exhaust into a muffler. Of the other principal structural features not already described or shown by the drawings, it may be noted that the crank shafts, connecting rods, etc., are of machinery steel. All nuts are finished and case hardened. Brass bushings are used on all crank-shaft boxes and phosphor bronze on all crank boxes. Both stationary and marine engines are built and both single and double cylinder engines. The single cylinder engines vary from 1-HP. to 15-HP. capacity, and the double cylinder, which, of course, gives the crank shaft two impulses per revolution, vary in capacity from 4 HP. to 30 HP.

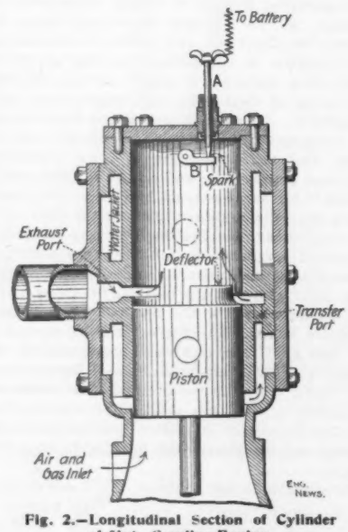


Fig. 2.—Longitudinal Section of Cylinder of Sintz Gasoline Engine.

With regard to the efficiency of the Sintz engines no records of tests are available, but the builders claim for the gas engine using illuminating gas a consumption of only 15 cu. ft. per HP. hour, and for the gasoline engine the consumption of but one gallon of gasoline per horse-power per ten hours.

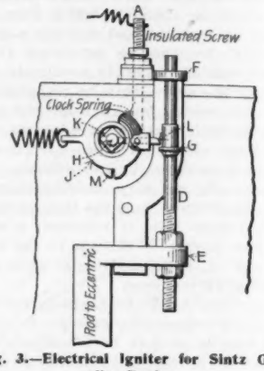


Fig. 3.—Electrical Igniter for Sintz Gasoline Engine.

THE ANDREE BALLOON EXPEDITION TO THE NORTH POLE.

We are indebted to Mr. Edward Grafstrom, C. E., of Columbus, O., a personal friend of Mr. Andree, and in receipt of late letters from those associated with him, for the material used in the following notes upon this daring undertaking. As the attempt to reach the North Pole by a balloon, desperate as it is, is the outcome of careful engineering study, planned and practically carried out by engineers, the subject is of interest to members of that profession. The fact that Andree was backed in his efforts by King Oscar, of Sweden, and by Baron Dickson, and that his plans had the approval of the Swedish Academy of Science, are sufficient guarantees that there was some chance of a successful outcome, and that failure could not be charged to any lack of intelligent preparation.

Soloman A. Andree was born in 1854 in Grenna, Sweden. At the age of 18 he entered the Polytechnic Institute of Stockholm, and then served an apprenticeship in the great machine shops of Motala, employing 5,000 men. Later, he traveled extensively, visiting the Philadelphia Exposition of 1876, among other places, and on his return to Sweden he became Master Mechanic at the Spannhults shops, and in 1880 he was appointed instructor in applied mechanics at the Polytechnic Institute at Stockholm. In 1882-83 he was a member of the Swedish expedition to Spitzbergen, and spent a long winter there in observing atmospherical electrical phenomena. In 1884 he was made Chief Mechanical Examiner of the Swedish Patent Bureau, and still holds that position. From 1886 to 1889 he was also acting professor in experimental physics at the Stockholm Technical College. In 1892 he was selected by the Swedish Academy of Science to undertake a series of balloon ascensions in their interest and at their cost, and he made five trips in all, one of them across the Gulf of Finland. The Academy published the result of his observations during these trips. Two years ago he laid before the Academy his plans for examining the polar regions from a balloon. He estimated the cost of the expedition at $35,000; and towards this sum the King at once subscribed $8,000; Baron Dickson subscribed another $8,000, and the late A. Nobel, the millionaire discoverer and manufacturer of explosives, gave $17,500. To this sum Civil Engineer Lamm added $1,500.

With this sum available, Mr. Andree went to work. After consulting the best authorities on the

Continent, he finally contracted with Mr. Henri La Chambre for the construction of his balloon; Mr. La Chambre had previously built many balloons and had himself made about 300 ascensions. His companions for the trip were selected from a number of volunteers. Mr. Nils Strindberg is 25 years old; a Bachelor of Science of Upsala University, and he has made a special study of atmospherical and electrical phenomena. He is also an expert in aerial navigation; is trained in out-door sports and is an expert photographer. The second companion, Mr. Knut Frankel, is 27 years old; graduated in 1892 as a Civil Engineer at the Polytechnic Institute, and has passed examination for admission to the Royal Engineers. He is strong and hardy; a champion skater and snow-shoe runner and an experienced hunter in Arctic lands. Mr. Frankel will attend to the "bird's-eye view" mapping and measuring, while Mr. Strindberg will have charge of the various instruments. Lieutenant Swedenborg, who went to Dane's Island as an alternate, and has now returned to Sweden, is a son-in-law of the Arctic explorer Nordenskjold.

From a late illustrated article in "Le Genie Civil," the following further notes are made relating to the transportation and inflation of the balloon itself on Dane's Island. The first expedition left Gothenbourg on June 7, 1896, for the preliminary work, accompanied by Mr. La Chambre, the builder of the balloon, a scientific staff from the University of Stockholm, and a corps of assistants selected entirely from the engineering students of the Polytechnic Institute of Stockholm. After close examination of various points, Mr. Andree finally selected the north coast of Dane's Island as a point of departure. This island lies just south of Amsterdam Island, off the west coast of Spitzbergen, and in about latitude 80° North, and longitude 10° East from Greenwich. In a straight line across the Pole the distance from Dane's Island to the north coast of the American or Asiatic Continent is about 2,112 miles. The expedition landed the case containing the balloon, the hydrogen gas generators and the material for erecting a scaffolding in which to inflate the balloon protected from wind, etc. This scaffolding was octagonal in shape, built in four stages, each 16.4 ft. high, held together by bolts. It was surmounted by a balcony accessible by two stairways, and was covered on the outside by sheet iron plates swung on wire ropes. The hydrogen gas generator, with a base of sulphuric acid and iron filings, had a capacity of 60 cu. m. per hour. The setting up of the plant was accompanied with many difficulties, as the envelope of the balloon alone weighed 3,080 lbs. and the network weighed 990 lbs. more.

By July 21, 1896, all was ready to inflate the balloon, and the gas generator was started. But snow commenced to fall, and the heavy coating on the balloon added to the trouble; and finally, when the balloon was partialy inflated, the pump used in connection with the production of the gas failed, and the supply of gas stopped. Then, too, the prevailing wind came from the north and northwest instead of from the south, as expected. Under these adverse conditions, and with a supply of gas in the balloon that it was estimated would not last more than 40 to 50 days, Mr. Andree reluctantly gave up his first attempt, and on Aug. 21 the party sailed for Sweden with all its appliances.

As described in "Le Genie Civil," the balloon itself was arranged as follows: The balloon was of the ordinary form and made of exceptionally good material; but beneath it was suspended a closed car, lighted by two lateral windows, and covered with canvas. In the middle of this car was a sort of sleeping compartment, fitted with reindeer skin sleeping bags. The sides of the car were provided with compartments for holding books, charts, instruments, arms, ammunition, toilet articles and cooking utensils. This last operation was performed by an alcohol lamp enclosed in a cylinder and so arranged as to be lowered about 33 ft. below the car through an opening in the bottom. By special mechanism, connected by a cord with the car, a match could be struck and the lamp lighted; and this lamp was blown out through a rubber tube before the apparatus was hoisted in the car again. A mirror, arranged at an angle of 45°, enabled the travelers to watch the flame. In this cylinder were also enclosed small vessels in which any liquid could be quickly boiled. At the distance of about a metre above the roof of the car was a circle mounted upon a ball-support so as to maintain a horizontal position; and upon this were arranged the sextants, theodolite, barometer, thermometer and the photographic apparatus.

This car was suspended to the balloon belt by six cords, held out by a cable in a hexagonal form; and between this cable and the roof of the car were six canvas pockets, with compartments intended to hold objects or instruments for instant use. Attached to the suspension belt of the balloon was a flat rim, divided into boxes and carrying four baskets, in which were anchors, buoys, cordage and other accessories. To an opening in this rim was suspended a rope ladder attached to the tail of the balloon and leading to the car. This arrangement permitted an inspection of the balloon by bull's-eyes in the safety-valve; and the rim afforded a place of refuge if for any reason the car had to be abandoned. To the suspension belt was also fixed a differential pulley and tackle, to be used in manipulating the guide-rope, whose action, combined with that of sails fixed to the belt by hempen cords, was expected by Mr. Andree to assist in keeping the balloon in the required direction and in guiding it generally.

These guide-ropes were made in several sections, united by screw-unions. By the aid of a wrench with two bevelled pinions it was possible to turn the guide-rope around its own axis and unscrew the lower section if this were caught between blocks of ice; the rope would be lengthened by again adding a new section at the top. By an ingenious attachment of a peculiar steel spring to each joint, the resistance to unscrewing at each joint was such that the bottom section always became first detached when the winch was turned. These guide-ropes were coated with vaseline to render them buoyant and to enable them to glide easily over the ice. The suspension belt of the balloon was held up by 48 cords, and in the intervals between these were fastened sleds, canoes, oars and masts, which were to be used in case the voyagers had to abandon the balloon; and, lastly, in canvas sacks were enclosed all manner of preserved food, chocolate, compressed bread, concentrated milk, champagne and Bordeaux wines, alcohol, etc. These sacks alone weighed 2,200 lbs. and served as ballast in case of need.

Returning now to our correspondent, Mr. Grafstrom, for information concerning the actual departure of Mr. Andree and his two companions this year, we find the following notes: According to Mr. Andree's calculations, his speed should average 16 to 17 miles per hour, or 400 miles per day. These figures were arrived at after a careful study of the summer air currents blowing over Norway towards the North. At this rate he would reach the North Pole in about 43 hours after the start, and cross to Behring Sea in six days. These air currents generally deviate to the west; but Mr. Andree believed that he could overcome this by the use of his sails and guide-ropes, or drag lines, as previous experiment had demonstrated that he could thus shape his course 27° to either side of the direction of the wind.

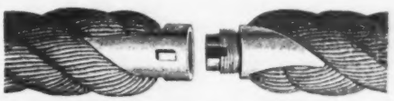
The actual start was made this year on July 11, under somewhat hasty conditions, accounted for by favorable winds, etc. At this time the wind was blowing a 22 mile gale from S.S.W.; if this wind kept up, Mr. Andree should make the total passage in about four days; and, says Mr. Grafstrom, he may have descended, about July 15, at some point east of 180° W. longitude, between the Gulf of Anadyr, in Asia, and Mackensie Bay. If this were so, he would probably make for Port Barrow, often touched at by whalers; or he may meet whaling ships at some of the small islands north of Behring Strait.

On the morning of July 11 the several trial balloons sent up sailed rapidly to the North, and Mr. Andree determined to start. It being Sunday, a short service was first held on the deck of the supply vessel, "Svensksund," and at 10.30 a. m. preparations were commenced. The balloon shed was partially torn down, the ballast, supplies, instruments, etc., were packed away, and at 2.15 p. m. the great balloon, inflated with 150,000 cu. ft. of gas, was ready. Andree, Frankel and Strindberg climbed into the car, and at 2.35 p. m. the last line was cut and the balloon was off on its voyage of adventure. At the height of 200 ft. above the ground a sudden gust drove it across the island, and there was some danger of it striking the high cliffs; but the strong southwestern breeze caught it in time and sent it out and over the sea. It was at first pressed down so hard by the wind that for some seconds the car dragged in the water; but it soon began to rise, cleared the rocks of Fogelsang Island by a few feet and then settled down to a steady progress northward and vanished from sight at about 3 p. m., at a height of about half a mile above the sea.

After the departure, it was discovered that three of the drag-lines, upon which Andree so much depended, had been torn loose, and were left upon the balloon shed. Their loss accounts for the height to which he rose above the sea. It was hoped that when they were torn away the manipulating gear of the sail and ropes was not injured, as without these he was at the mercy of the wind alone; and if this should veer he might drift past the objective point hundreds of miles away. But as the ballast in the car consisted largely of reserve lines, the lost lines were probably soon replaced. Andree took with him some carrier pigeons; and though there are rumors of the return of pigeons, no authentic story of their flight from Andree's balloon has been received. The ultimate fate of these brave men is yet to be disclosed—if it ever will be told at all.

A GERMAN ROPE COUPLING.

The coupling for hemp or manila rope, which is shown herewith, we find described and illustrated in "Uhland's Praktischer Maschinen-Constructeur." As seen in the cut, it consists of a male and female screw coupling. The strands of the rope are drawn



A German Coupling for Hemp or Manila Ropes.

through slots at the ends of the device and spliced back. When the coupling is connected, the key is driven into the slot and prevents the parts from unscrewing.

An advantage of this coupling on ropes used for hoisting is that the diameter of the coupling is less than that of the rope, so that it does not come against the drum or spool when the rope is wound in by a hoisting engine. The coupling is made and sold by the Bremen-Tauwerk-Fabrik, A. G., Bremen, Germany.

A HOLLOW CABLE was recently tested between Beaulieu, in Hampshire and Gurnard Bay, in the Isle of Wight, a distance of nearly two miles, the object being to ascertain the capacity effect. The cable used was manufactured under patents owned by Messrs. Willoughby Smith and W. P. Granville and had a cross-shaped air space in the gutta percha insulation. The four conductors, each consisting of several strands of small copper wire twisted together, were imbedded in the V-shaped solid portions between the arms of the cross. Specimens of such cable were submitted to a hydraulic pressure of 700 lbs. per sq. in. for a considerable time with no apparent effect. In testing the section already mentioned two wires were employed in the ordinary manner while the other pair was earthed, looped and left open with no noticeable change in the capacity effect. At another time one pair was employed as a telephone circuit while a heavy alternating current was sent through the second pair, producing no effect on the telephones. The expense of construction and chance of accident are naturally increased, but the following figures show a great superiority as far as the capacity action is concerned:

	Per knot— New.	Old.
Copper, lbs.	941	940
Gutta percha, lbs.	940	5,100
Resistance in ohms	5,163	5,193
Inductive capacity bet. diag. wires in micro-farads	.098	.108

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The failure of commercial attempts to supply fuel gas to cities in the United States is strikingly set forth in an exhaustive paper by Mr. F. H. Shelton, of Chicago, abstracted in another column. The paper, it must be understood, does not deal with the isolated plants for making fuel gas for use on the premises in manufacturing purposes, nor with the supply of illuminating gas for fuel by illuminating companies. It deals wholly with commercial attempts to supply a cheap non-luminous gas as a substitute for coal or other forms of heat for domestic and manufacturing purposes.

The number of attempts described by Mr. Shelton is 27. These have been made under a variety of conditions, in both large cities and small villages, and all but five have utterly collapsed, while of these five two have been trying to change to illuminating gas, one plant is operated chiefly to furnish gas to a large manufactory, and the other two, although in operation for a number of years, have never paid a dividend. Ten of the attempts Mr. Shelton characterizes as raids upon existing gas companies, six of which resulted in consolidation and the abandonment of fuel gas. Fourteen of the trials are characterized as genuine attempts to meet an apparent demand for fuel gas. Several plants have been promoted by persons interested in selling patent rights.

The general cause of failure, especially of the legitimate attempts, is the simple fact that the public soon finds out that the low prices charged for fuel gas are accompanied by low heat units, so that no economy results, while the fuel gas is more dangerous than the illuminating, in case of leaks, and necessitates two sets of pipes, if gas is desired for lighting. Prices cannot be put, or kept, low enough to compete with illuminating gas, which, with the disadvantages of use just cited, results in lack of customers and financial failure, unless a change is made to illuminating gas.

In these hot summer days, readers who look for something in the shape of "light reading" in these columns may be interested in a recent addition to our collection of curiosities, in the shape of another claimant to success in the transmutation of metals. Mr. Stephen H. Emmens, of "Argentaurum" fame, professed to be able to make silver into gold. His newly announced rival, one Edward C. Brice, claims to produce gold from antimony. The tale of his successes and failures was told some time ago in the New York "Sun;" and a gentleman who was concerned in an investigation of Brice and his alleged process recently entertained one of the local engineers' clubs with his experience.

As related in the "Sun," the facts are briefly as follows: Brice filed an application at the Patent Office on May 7, 1896, for a patent on a process for creating gold and silver, claiming that he could produce them from such metals as lead, tin and antimony. The application was rejected, of course, on the ground that the process had not been shown to be workable, but Brice demanded an opportunity to demonstrate his process by a laboratory test. The laboratory connected with the Patent Office was not equipped for such a test as was necessary, so application was made to Secretary Gage to have the test made in the laboratory of the Mint, and he instructed Director of the Mint Preston to have a thorough investigation made of the process. In accordance with these instructions Director Preston appointed Messrs. Andrew Mason, Superintendent of the New York Assay Office; D. K. Tuttle, of the Philadelphia Mint, and Cabell Whitehead, Assayer of the Mint Bureau at Washington, as a commission to test and report upon the alleged process.

It may be thought rather strange that the Department authorities should have taken such pains to test the soundness of so chimerical a scheme, but it was vouched for on very high authority. For example, if we may believe the "Sun," Brice and his associates submitted to Secretary Gage, among other documents, a report by no less an authority than Mr. Robert W. Hunt, which we quote from as follows:

> At the request of Messrs. Charles W. Holmes and Austyn Granville, of this city, we beg to state to you that, acting as a commission from them, we have made a number of tests of a formula given us by E. C. Brice, by which he claimed gold and silver could be produced. Naturally we approached the proposition with hesitation, and took great precautions to avoid making mistakes. The writer procured the substances treated from Messrs. Richards & Co., limited, 108 Lake St., Chicago, an old establishment of high reputation. They furnished them as being "chemically pure." Before using them we tested them in our laboratory and failed to find any trace of either gold or silver. Following Mr. Brice's formula, we obtained both metals. In the test just completed the results were: Gold, $3.10; silver, $1.04 per ton. The investigations were conducted under the personal supervision, participation and constant presence of the writer and absence of any outside parties.
>
> Mr. Brice, in giving us the formula, stated it was a special laboratory one, prepared by him to demonstrate that gold and silver could be produced from materials in which they did not exist; and that on the same principle he (Brice) was able in his establishment to produce those same metals on a commercial and paying scale, and can so demonstrate.

Naturally this statement from such high authority had its weight with the Treasury Department officials; and besides this, some Chicago business men and financiers personally known to Secretary Gage reported that the claims of Brice and his associates had every appearance of soundness.

It is interesting to note, moreover, that a proposition was seriously made to the Government authorities for the purchase by them of Brice's secret. The reason given why a sale to the Government was desired was a plausible one. In order that the process should be worked on any considerable scale the secret must be imparted to workmen and others; and what man would continue to labor for wages when the secret of making gold was in his possession? The Government, however, could surround such a process by safeguards in the shape of laws to prohibit its unauthorized use. To prove their good faith, Brice and his associates offered to accept Government bonds in payment for the secret and to forego for two years the payment of the interest. In that time, if the process were genuine, the Government could manufacture enough gold to pay the bonds, principal and interest; and if the process were not genuine, the bonds would be nullified.

These are but samples of the arguments by which the Government officials were persuaded to make a thorough test of the Brice process, as stated above.

The report of the commission of assay experts named above was submitted to Director Preston on May 21. We make the following extracts from it:

> While seeking for pure antimony, we accepted the offer of Mr. Brice, that he should supervise and direct a trial of his process upon antimony known to contain small amounts of silver and gold, and that he should conduct an assay of the same antimony, for a comparison of results from his own assay methods with those from his creative process. His assay, in which he scorified one-half assay ton of antimony (one assay ton equals 29.166 grams) with one-half assay ton of lead, showed the antimony to contain 0.060 oz. of gold and .317 oz. of silver per ton.
>
> Mr. Brice now subjected 5 oz. of this antimony to his creative process. His yield, after treatment, showed gold 0.084 oz. per ton of antimony, and 0.670 oz. of silver per ton of antimony used.
>
> Your committee followed up the work by making an assay of the same metal, following well-known and approved methods of assaying, with the following results: Gold 0.100 oz. per ton and silver 1.20 oz. per ton of antimony. A comparison of this result will show that Mr. Brice found by his assay 60% of the gold and 26% of the silver actually present in the materials used. By his "creative" process he recovered 84% of the gold and 55.84% of the silver originally present in the materials.
>
> A most interesting result of the commission's labor was that they found that all available samples of metallic antimony, including those sold by dealers as chemically pure, contained minute but appreciable amounts of gold and silver. As the most satisfactory proof of the falsity of Brice's claims, the commission prepared by the Capitaine process antimony which should show upon assay no trace of gold or silver, and then operated Brice's process, according to his directions, upon this metal. No trace of precious metal was found as the result of the process. The conclusions of the commission are summed up as follows:
>
> During these experiments, which have now extended over some three weeks, and have involved an amount of painstaking labor, which we hope has not been entirely wasted, we have seen not the slightest evidence of any creation or transmutation. On the contrary, the claimant failed in every instance to recover the entire amount of silver and gold known to be present in the materials. The claimant seems to have devised a variety of irrational and wasteful methods for recovering a portion of the silver and gold known to metallurgists as being present in many commercial metals, such as antimony and lead.

It seems strange, indeed, that near the close of the nineteenth century schemes for the transmutation of metals, that ignis fatuus of the Middle Ages, should be seriously brought forward and find so much support and credence as to make it necessary to demonstrate their falsity.

It is interesting in this connection to note the latest claimant to success in that other hopeless search which has deluded so many thousands of schemers ever since the dawn of history, the quest for perpetual motion. "The American," the leading paper of Nashville, Tenn., devoted large space in its issues of June 3 and June 6 to an account of a "revolving mechanical wheel," the invention of W. J. Gladish of Chattanooga, Tenn., "which is claimed to have solved the problem of perpetual motion." The principle is one which has been tried by many searchers for perpetual motion. Weights are suspended from the spokes of a wheel in such a manner that they are supposed to take by gravity a position near the rim of the wheel when on the descending side, and near the hub when on the ascending side. The fallacy involved in the scheme has been so often shown that it is not necessary to demonstrate it here. As an excellent example of the credulity with which such chimerical schemes are received, we quote the following from the "American:"

> The Tennessee Centennial, already distinguished for its triumphs in the field of invention and science, has added the crowning copestone to its achievements.
>
> The problem of perpetual motion has been solved. Like all other great inventions, the thing seems simple enough when it has been done.
>
> In the wheel to be exhibited, so much speed is generated that it would tear the wheel to pieces were it not restrained. A belt over the wheel is attached to a gearing, which regulates the speed of the wheel.
>
> When the subject of making such an exhibit at the Centennial was first broached, Maj. Lewis appointed a committee of Chattanooga men, of which Newell Sanders was chairman, to investigate and see whether the machine was a fake or not. The report of this committee has already been received by Maj. Lewis. The committee stated that they had watched the wheel for two hours and fifty-four minutes, and that to all appearances it possessed continuous motion.
>
> The invention is the result of eighty years of continuous study. The father of the present Mr. Gladish worked during the best years of his life on a wheel somewhat similar to the present one, but was never able to produce a practicable machine. His son took up the study of the subject where his father had left off, and after twenty years of struggle at last perfected the present machine.
>
> The appearance of the man at once suggests an inventor. His long hair reaches to his shoulders and his diffident air repels the inquirer. His whole life has been wrapped up in the invention, and he has scarcely thought of the outside world further than to stop his work long enough to earn money for the actual necessities of life. But success is his and he can afford to laugh at the opinions of

the world which have branded him as a dreamer, a man with "wheels."

If the invention is the success claimed for it, and there seems to be no reason to doubt it, the motive power system will be thoroughly changed. Instead of looking to steam and electricity, the power will be found in never decreasing quantity from a source which can never fail, gravitation.

We will take space to record one more choice specimen recently added to our collection. This is the "Hawkins" steel process, which was widely heralded by the daily papers not long ago as "about to supplant the Bessemer process." One journal gave the following remarkable description of this process:

> The process consists of sending simultaneous blasts of hot air and steam, at right and acute angles, respectively, into a falling stream of molten iron. This, say its supporters, will effect all that the Bessemer process does by means of oxygen, and the hydrogen will also deoxidize the sulphur, converting it into illuminating gas, which can be drawn off and used for lighting purposes, and changing the phosphorus into phosphorid pentoxide.

The choice illuminating gas which would result from the union of hydrogen and sulphur will be familiar to any one with the most elementary knowledge of chemistry. The quotation is by no means an extraordinary example of the absurdities which the daily press continually serves to its readers. Is it any wonder that the average intelligent business man, who relies solely on the daily papers for information concerning progress in scientific and technical matters, is frequently the credulous victim of the promoters of such schemes as we have described above?

Our attention has been called to the fact that in our report of the late convention of the American Society of Civil Engineers at Quebec, the courtesy of the special train to the Indian village of Lorette was credited to the Mayor and Council of Quebec. This was incorrect. The thanks of the Society for this interesting excursion are really due to the Directors of the Quebec & Lake St. John Railway Company, and especially to Manager J. G. Scott, through whom the special train was obtained, and to whom the members are indebted for organizing and carrying out the several pleasant incidental features of the trip.

GOOD DISCIPLINE AS A FACTOR OF SAFETY IN TRAIN OPERATION IN ENGLAND.

The far greater perfection in safe train operation which is attained by English railway managers is always envied by the American, who takes a just pride in the truly great development which the railway transportation system of his country has reached in most other respects. According to the last special report of the British Board of Trade on railway accidents, the total number of passengers and employees killed by train accidents of all kinds on the railways of Great Britain in 1896 was eight. During the same twelve months accidents to trains were responsible for the injury of 549 persons. A direct comparison of American fatalities in train accidents with these figures is not possible, but, unfortunately, one is not needed to show very clearly that railway traveling in England is much safer than in the United States.

Why English methods of train practice should be safer than American is often not quite clear to one who looks for the explanation only to the comparative excellence of the mechanical features of the railways of the two countries. The reason, however, is made plain by the Board of Trade report, if one goes beyond the summaries of the secretary and studies the detailed reports of the official inspectors. This will necessitate some dry reading, but it will bring out very strongly the fact that the greater safety of train operation on English railways is not due entirely to their rolling stock and roadbed, nor to their universal use of block signals, but is largely the result of the close public surveillance of accidents and the more perfect discipline of railway employees in matters of safety. As these are phases of the subject concerning which current articles on English and American railway practice are commonly silent, it may prove interesting to see what information of value the Board of Trade report can give us concerning them.

Perhaps the first thing that attracts the attention of the American who reads the detailed reports mentioned above is that small accidents involving trivial damages are as conscientiously investigated as the really serious disasters. In a number of instances in the report for 1896 several pages of evidence are found which relate to a collision of switched cars with a bumping-post, in which only slight damage was done to the cars and no one was injured. In fully a score of other instances the accidents reported upon are hardly more serious, they usually being yard and terminal collisions involving only minor property damages. It is safe to say that probably 50 per cent. of the accidents investigated by the Board of Trade experts in 1896 would hardly receive in America the personal attention of the managers whose roads suffered the injuries, and the advisability of investigating them in the interest of the public would never be thought of.

It is also noticeable in reading the reports that the same tendency toward minuteness characterizes the manner of conducting each investigation made by the Board's report. The end aimed at seems to be always to determine the exact cause of the accident and to fix definitely the responsibility for it, and no item of evidence is neglected which will be helpful in this work. A very good idea of the detailed nature of these investigations is given by any one of the printed reports. In these a description, and often a plan showing the layout of the tracks, signals and line structures at the site of the accident, is given. This is followed by a statement of the rules governing train and signal operations, and the presentation of all evidence showing whether these rules were violated at the time of the accident, and whether they are always closely followed under normal conditions. The mechanical condition of the rolling stock, track and other equipment before the accident is ascertained, as well as the damage done by the accident. The testimony of all employees concerned in the accident is taken in detail. The name, length of service, time on duty, previous record and experience and personal habits of each employee is ascertained. Finally, the investigation closes with a formal decision placing the responsibility and cause for the accident, recommendations for improvements, and a more or less severe censure of each person responsible in any way for the error. All these details are carried out as fully in a bumping-post collision as in an accident where a considerable loss of life and property result.

Passing now from its methods of work to the results of the Board of Trade's investigations for 1896, the reader is struck with the fact that carelessness was in most cases responsible for the accidents reported upon. Of the 36 accidents concerning which detailed reports are given, all but a bare half-dozen were due to the thoughtlessness of some one; a signal was disobeyed or a wrong signal given, switching operations were carried on at too great a speed, or instructions were misunderstood, or some other blunder was committed. Fully 60 per cent. of the collisions recorded were caused by the misunderstanding or disobedience of signals. Only in two or three instances could the responsibility be placed upon mechanical defects in the rolling stock or line equipment.

For the present purpose we need not enter any further into a study of the Board of Trade report. Summarized briefly, the salient features already brought out are: (1) All train accidents involving either damage to property or loss of life are investigated; (2) The investigations are conducted to determine particularly the cause of the accident and the person responsible for it; ((3) Carelessness is in most cases responsible for train accidents, and not mechanical defects. What remains to be considered now is, whether these facts have any influence upon the safer conditions of train operations on English railways.

It seems evident to us that this searching public investigation of faults in train operation, which in themselves may be insignificant, must exert a powerful influence toward the prevention of accidents, if the proper methods are taken to make it felt. When a railway manager knows, as every English manager does, that if a train accident occurs on his line the reason and responsibility for it will be investigated by unprejudiced experts, and that the testimony of his employees, and perhaps himself, will be collected and sifted and finally made public, with a censure fitting the case, he will be less sensitive than most men if he does not keep a sharp lookout that there shall be few occasions for criticism. The same influence is scarcely less powerful upon the employee. The engine driver, conductor, signalman, yardman, or employee of whatever degree, who sees the responsibility of his error placed upon his shoulders without qualification or excuse, and knows that his employer and fellow workmen and the public will know his fault, must be an unusually worthless one if he does not try to redeem himself in his future actions.

This effort to bring out clearly the causes of railway accidents, and particularly the personal responsibility for them, is the chief difference which distinguishes the British Board of Trade's investigations from the work of similar public commissions in this country. The official reports of the Interstate Commerce Commission and of the various state railway commissions, so far as we recall, relate only to accidents from which personal injury results. It has followed quite naturally, therefore, that these bodies have in a degree lost sight of the fact that a study of the causes of accidents with the idea of suggesting corrections, is far more important than compiling statistics of the killed and injured and evolving general conclusions. It is, doubtless, this very line of thought which has determined the policy of the Board of Trade in extensively studying minor accidents, and it is plain, too, that an accident relatively insignificant in the destruction of life and property may afford as good an indication of error or carelessness in train operation, which needs to be corrected in the interest of safety, as does a disaster notable for its fatalities.

This is equally true whether the fault is one of the mechanical equipment and maintenance; of the operating methods, or of the discipline of employees. It is in its influence upon good discipline, however, that the systematic investigation of accidents along the lines adopted by the Board of Trade's experts is especially valuable. Prompt obedience to authority and unquestioning and vigilant compliance with established rules are not easy to secure from railway employees under the best conditions, and any influence which will aid the railway manager in this important work is of great value. In a censure for carelessness from a public commission, whose statements cannot be successfully refuted by the employee, the railway manager, has a powerful weapon for impressing upon him the necessity of obedience and carefulness in carrying out established rules. It is plain also that the weapon is just as efficient against the manager himself when he is the one in error.

The very fact that the Board of Trade investigates all accidents, whether they involve personal injury or not, and that its inspectors are as careful to determine and place the responsibility for neglect or disobedience in a switching collision as in a serious disaster, obviously gives this commission much of its power. An employee cannot commit an error which involves even slight property damage without rendering himself liable to be called before the Board. This Board thus assumes a real personality to him, which it would not assume if accidents involving loss of life only were investigated, or if no attempt was made to point out and criticise his personal responsibility for the damage done.

It may seem to some readers that we are giving undue importance to the part which carelessness plays in causing train accidents. The evidence of the Board of Trade report upon this point has already been given, and statistics of train accidents in America show the same thing. It is very necessary that there should be no misunderstanding regarding such facts. American railway men too frequently assume that the reason for greater safety of train operation on English railways is to be found in some feature of their mechanical equipment. The real fact of the matter is that, except in their universal use of block signals, and on the average somewhat better roadbed, English railways have few improvements to offer to American practice in the way of mechanical appliances for securing safe train operation. On the better equipped American trunk lines, moreover, both roadbed and signal systems are fully as perfect mechanically as on English

railways, and in the use of track circuits and other controlling devices for fixed signals American roads have a distinct advantage over British practice. If these American lines were as free from train accidents as English roads, it would be fair to presume that the fact was accounted for by their good mechanical equipment alone, but when this is not the case we are justified in assuming that some other factor may be responsible for the difference.

One who studies the question carefully, is, we think, pretty sure to reach the conclusion that the better discipline of trainmen on English railways, if it is not the principal reason for their safer operation, is at least an important one. Care should be taken here not to mistake mental alertness and mechanical ability for discipline. In the former qualities the American railway employee has no superior in the railway employees of any other country, but he certainly is not so well trained to obey authority, nor is he held so strictly accountable for breaches of discipline as the English employee. To a considerable extent American railway managers are responsible for this fault, but it is also partly the result of conditions which have grown out of the rapid development of a great railway system in a new country.

A case in point which is especially instructive is the respective training which the employees of the two countries have received in operating trains. On all American roads at the beginning train operations were conducted on the time interval system, and comparatively few railways, and these only very recently, yet have block signals for controlling train movements. It is not very surprising, therefore, that the American trainman, brought up for years to depend upon the time interval and the rear flagman to prevent collision, does not see any enormity of offense in overlooking or disobeying a block signal, since by doing so he feels that he is only returning to an older and more familiar system of running trains.

Unfortunately, American methods of operating block signals are often such as to encourage the trainman in this feeling. Upon what would seem a very small excuse to English engineers, American railway managers will suspend absolute block working and substitute for it permissive blocking. There are, doubtless, many instances in which this action is justifiable, and even necessary, but the tendency often is to make the change on very little provocation, and to keep it in force long after the temporary need is satisfied. The step from permissive blocking to the time interval system is a short one, and is easily made in practice if it is not carefully guarded against. It is a fact often commented upon that one may frequently see a system of permissive blocking in temporary use where the space interval has been totally abandoned, and each train is as dependent upon its time interval for safety as if the block system did not exist. It needs no argument to show that this sort of train practice tends to lead trainmen to think that block signal instructions may be superseded by verbal orders at almost any time, or even disobeyed on their own responsibility, if time is to be made up or a crowded yard is to be cleared.

The course of training which English trainmen have had in the use of block signals is quite a different one. They have been taught to hold the instructions of fixed signals as authority above everything else, and permissible of violation only upon instructions from the most indoubted sources. In this they are upheld by the Board of Trade, and it is a common thing to see in the reports of this body all blame withdrawn from the trainmen, and the official who countermanded the fixed signal instructions severely censured. A large proportion of the greater efficiency of block signals on English railways is without doubt directly due to the fact that the railway employees in that country have been longer and more thoroughly trained in their use than they have in America.

The prominent part which discipline plays in the safety of train operation is more fully appreciated when we remember that the bulk of the loss of life in train accidents results from errors in train operation, and not from defects either in the rolling stock or roadbed. This statement has already been made in another form, but it needs emphasis. It has so happened that the train accidents which have lived longest in the memory of Americans—the disasters at Ashtabula, Woodstock, Bussey Bridge, etc.—have been due to mechanical defects; but the accidents that have run up the longest death list year after year have resulted from faults in train operation, generally from collisions. This fact is true even on our best-signalled railways.

In emphasizing the need of discipline so fully, it should not be understood that we intend to belittle the value of mechanical aids to safety in train operation. It is plain to any one that our rolling stock, signals and roadbed cannot be made too perfect in this respect. But it is just as important that our rules for train operation shall be equally well cared for, and above all that our system of discipline shall be such as to keep employees up to the standard set by these rules.

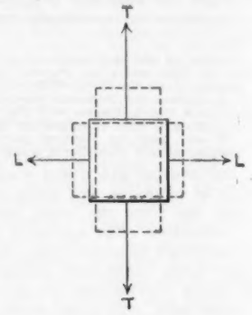
LETTERS TO THE EDITOR.

Bursting Strength of the Boiler Tested at St. Louis.

Sir: Permit me to submit to you a few lines on the computation of the breaking tension of the boiler tested as described in your issue of July 1. In a cylindrical steam boiler there are two kinds of tension. The ring tension $T = N r$ is in the tested boiler $900 \times 30 = 27{,}000$ lbs. per inch of length, and besides that the axial tension $L = N r^2 \pi \div 2 r \pi = \frac{1}{2} N r = \frac{1}{2} T$, or here 13,500 lbs. per inch of a ringwise section. Each tension causes in its direction an elongation of an element of the boiler skin, but also a contraction in a direction rectangular to the first one amounting to about ¼ of the elongation. Now the elongation in the direction of the ring is $dr = (T - \frac{1}{4} L) \div E = (N r - \frac{1}{4} \frac{1}{2} N r) \div E = \frac{7}{8} N r \div E$, and the elongation in the direction of the boiler axis $dl = (L - \frac{1}{4} T) \div E = (\frac{1}{2} N r - \frac{1}{4} N r) \div E = \frac{1}{4} N r \div E$. In this way the two kinds of tension counteract each other in the effect upon the element. The breaking of the boiler shell depends upon the limit of elongation which an element can stand, and if the then existing tension t is wanted it will be found $t r = dr E = \frac{7}{8} N r$ in the direction of the ring, or $6 l = dl E = N r$ longitudinally. Consequently the first break must occur as shown in the illustration on page 12. When the St. Louis boiler plate of ⅝-in. thickness did break, the tension amounted to $t r = \frac{7}{8} \times 27{,}000 \div \frac{5}{8} = 63{,}000$ lbs. per sq. in. of ring section. This is only moderately in excess of the stamped 60,000 lbs. tensile strength. Yours respectfully,

Th. Hoech, M. Am. Soc. C. E.
German Embassy, Washington, D. C., July 12, 1897.

(We think the theory given in the above letter to explain the high bursting strength of the boiler tested at St. Louis is defective, in that it assumes that the elongation in each direction is uniformly proportional to the tension in that direction. This is true only within the elastic limit. In the case of the boiler the stress in the direction of the ring was practically equal to the ultimate or breaking strength of the material, while in the axial direction the stress was probably within the elastic limit.—Ed.)



Quick Renewal of a Burned Railway Bridge.

Sir: Three spans of the Cincinnati & Muskingum Valley R. R. bridge over the Scioto River, about one mile west of Circleville, O., were destroyed by fire about 1 p. m. Friday, July 30. The bridge was one with four single track, through spans of 150 ft. each in length, one of which was iron and the others Howe truss wooden spans. The Howe trusses were covered.

The fire started from a locomotive spark lodging on a top lateral brace. It worked its way under the wooden siding into the truss timbers, and 40 minutes after it was discovered the three spans were down and almost completely consumed.

Superintendent C. M. Bennett and Trainmaster O. V. Porter reached the scene about 4 p. m., and Engineer A. L. Morgan four hours later. Friday afternoon and night were spent gathering material and men and organizing the forces. About 70 carpenters and 30 section hands, with an ample supply of material were on the ground by noon on Saturday. The pile-driver was started from the east end, placing pile bents in the river, and the carpenters were started from the west end setting up framed bents. The bents from cap to sill ranged about 25 ft. in height. There are 21 framed bents beside the bents on the piers, and six pile bents in the new structure. The repairs were completed at midnight on Sunday and the track was ready for trains.

But 50 hours elapsed from the time the fire was discovered until the 450 ft. of bridge were replaced. Not all this time was required in the construction of the temporary bridge, as the men were allowed several hours rest at night. All the framed bents were in place at 3.45 p. m. Sunday. The actual time of construction was 38½ hrs., during part of which it rained, which comes

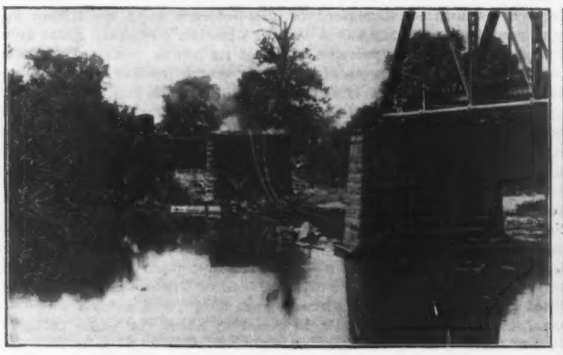


FIG 1.—VIEW OF RUINS OF SCIOTO RIVER BRIDGE, CINCINNATI & MUSKINGUM VALLEY R. R., SATURDAY MORNING, JULY 31.

FIG. 2.—VIEW SHOWING SCIOTO RIVER BRIDGE, CINCINNATI & MUSKINGUM VALLEY R. R., REBUILT, MONDAY MORNING, AUG. 2.

very close, if it does not break the record. During Sunday afternoon it required just 30 minutes to frame and erect a bent.

Mr. Bennett acted as general manager, Mr. Morgan as engineer, and Mr. Parker had charge of the commissary and transportation. I send herewith two photographs of the work, one taken Saturday morning, showing the ruins from the west end, and one showing the temporary structure completed. The pier under the west end of the iron span figured in a paper read by Mr. M. L. Byers, M. Am. Soc. C. E., before the American Society of Civil Engineers in 1894, and abstracted in Engineering News of March 22, 1894. F. C. Neeb.

Lancaster, O., Aug. 7, 1897.

Who is the Owner of An Engineer's Notes?

Sir: In answer to the inquiry of E. P. A., published in your issue of July 22, there are a large number of decisions on cases like the one quoted, these decisions being generally against the professional man. The cause of this is frequently that the evidence or argument is not adduced in such a manner as to show the reason for the right of the engineer to keep them. This right should be adjudged because the client employs the engineer (as a professional) to perform a certain duty. His profession requires experience as well as pure technical knowledge and it is part of his professional training to collect notes and data, especially if these are of a technical nature. If for the purpose of increasing his knowledge, refreshing his memory, or decreasing the amount of his labor, he makes notes, draws plans, or in any other way places such data in permanent form, the client has the right to claim this only when his employment of the engineer was for the purpose of accumulating such knowledge. This employment is one in which the brains, genius or experience of the engineer are wanted. In order to carry out his ideas it is necessary for him to make notes, prepare plans, draw up specifications, etc.; these are his aids and guide and represent the results he desires to achieve in the execution of the work. His commission or fee pays for the time and trouble he has had to take to evolve his ideas and carry out the work, but it should not include handing over the data which in effect are his stock in trade. To be compelled to give them to the client diminishes his chance of future employment, especially in cases like temporary abandonment before completion or in case of carrying out other work of like nature. He should no more be compelled to deliver them up than say a printer a set of electrotypes at the completion of a job; it is the printed material the customer pays for and not the tools or processes of manufacture. The notes, plans and other data are essentially instruments of service and as such belong to him as much as the pick and shovel belong to the laborer. They are there for the purpose of simplifying the work. As well might the client claim the drawing board or transit.

This line of reasoning, if properly carried out, might convince the court or a jury. We have still to hear of a final decision of record on this point.

Oscar Lowinson,
Jun. Am. Soc. C. E.

New York city, July 26, 1897.

The Pioneers of Centrifugal Pump Dredging.

Sir: Referring to the discussion in your issue of June 17, as to the "Pioneers of Centrifugal Pump Dredging," let honor be done those to whom honor is due.

The late Louis Schwartzkopf of this city was during his life a most prominent engineer and constructor, whose monument exists to-day in the form of one of Berlin's largest machine works, and it is hard to believe that the dredger which the Prussian government patented to him and to Baurath Hoffman was an "impracticable device"—such devices not being patentable under the law.

Many pioneers have allowed their brilliant ideas to be improved upon by others, while they devoted themselves to their other pursuits which promised a larger speedy and constant return, and yet those foundations upon which, in the progress of the arts and sciences, have been built great labor-saving machines should not be termed "abandoned experiments."

Baurath Hoffman, the colaborator of Schwartzkopf, too, has proved his worth, and should not be shorn of his glory because he devoted himself to his factories and allowed the germs of his genius to sprout under the hands of others.

Herr von Schmidt concedes to Schwartzkopf his mead of praise, but Mr. Bowers belittles what the records show. In 1856 Schwartzkopf and Baurath Hoffman invented and patented a hydraulic dredger. In their patents was described the use of a centrifugal pump on a boat connected to a sucking tube which was armed with a ploughshare-like basket, as, when "the sucking power is not strong enough, mechanical means are applied, such as scrapers, stirrers, cutters." "The sucking tube is moved to the right or left in a lateral direction." "The earth, being removed, is led by means of water through tubes to the place where it is to be deposited." The tube is connected "with a flexible joint."

Here is everything provided for: A boat with a pump and a sucking tube with means for tearing up the bottom and swinging laterally and finally the discharge tubes with a flexible joint.

This having been invented, even crudely, can only have been improved upon thirty years later. Why should not Bowers content himself with the improvements he patented later, and leave to the dead his rights to renown? Yours respectfully,

Louis Fischer.

Berlin, Germany, July 24, 1897.

A New Truss Design and Its Analysis.

Sir: Mr. C. L. Strobel's article, published in the Engineering News of July 22, on "A New Truss Design and Its Analysis," is a very interesting one for engineers interested in the theory and design of arches in both their forms, the upright and the inverted. It would be still more interesting and useful if Mr. Strobel had given the algebraic analysis of the form of truss described by him. It is well known that the inverted arch or suspension bridge appears in three different and distinct types. First, the chain or cable, with a stiffening girder hung from it; second, the spandrel braced suspension bridge, and, third, the suspension bridge "stiffened within itself," or braced chord bridge. The last type has more than one chord or cable, usually two, parallel or intersecting, which are braced together by web members and thus themselves form a stiff girder to take care of partial loads on the bridge, instead of the stiffening girder of the first type. Mr. Gustav Lindenthal's proposed bridge over the North River is a notable example of a suspension bridge with braced parallel chords. The Point bridge at Pittsburg over the Monongahela River is an example of this type, with intersecting chords and center hinge. This type of bridge seems to offer the natural and rational solution for the stiffening of suspension

Fig. 2.

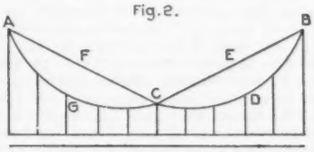


Fig. 1.

bridges. It is certainly true that well-conceived and developed details will make the braced chord bridges more economical than the suspended cable with the stiff beam hung from it, forming two wholly different systems.

In following the evolution of the braced chords suspension bridge it is interesting and instructive to note the various attempts of the designers to reach the best curves and forms; attempts which resulted in a number of different forms of the same type of bridge.

The Eads Arch, patented in 1874 by Capt. J. B. Eads, the already mentioned Point Bridge at Pittsburg, built in 1878 by Hemberle, may serve as examples. But in the Eads Arch, as well as in the Point Bridge the auxiliary members, in the former the curved upper chord, and in the latter the straight upper portion, are alternately subject to tension and compression, and they must, hence, be made stiff members. This, of course, is a great objection, especially for the long spans characteristic of modern suspension bridges where wire cables have to be used. To overcome this difficulty Prof. Claxton Fidler proposed in 1875 his form of suspension truss. This form is shown in Fig. 1. It consists of two chords each in equilibrium with one-half truss loaded. It is obvious that with the right half of the truss loaded the chord A F C D B will by the corresponding equilibrium polygon, and similarly A G C E B will be the equilibrium polygon for the left half of the truss loaded. It is also evident the portions A F C and C E B of the curves will be straight lines and tangents to the parabolas C D B and A G C. The chords will always be in tension, and eye-bar chains or continuous wire cables can be used for them. This form of suspended truss also offers a very good distribution of the bracing material between the two chords. In Prof. C. Fidler's form of truss whatever the ratio of moving to fixed load the chords will always remain in tension. But as the length of span increases the ratio of moving load to fixed weight of bridge decreases, and for a given length of span and moving load the maximum ratio of fixed to moving load is fixed. Now, the analysis of the truss under consideration will show that for all practical cases the upper chords will never be in compression even if we make them not in straight lines as in the Fidler truss, but curved and concave as in Fig. 2. This form shortens the web members, and hence saves material, while retaining all the advantages of the former type. M. Resal, in his work "Ponts Metalliques," 1893, gives a sketch of this truss, but without any analysis, and says: "Such is the type of the economic arch." In 1893 the English engineer, Max am Ende, published in the London "Engineer" an article on the "Theory of a Parabolic Arch with Three Pivots," where he gives the general formula of this form of truss for an upright arch. In making, three years ago, a study of suspension bridges the writer worked out the theory of this truss more fully for different forms of load, deflections, etc., and made an application of the same in a pretty full design of a 3,000-ft. span carrying six railway tracks under almost identical conditions as those of the proposed New York and New Jersey bridge. The results were very favorable for this form of bridge. The analysis of this form of truss shows that Prof. Fidler's truss is but a special case of the general form of truss with both chords curved and concave.

Mr. Strobel's design is nothing but a suspension truss with braced chords, with the horizontal pull being taken up by a strut between the points of suspension. The fact that the strut has a curved and arch-like form does not change its function at all. To the writer's mind it seems that the arched form of the strut has the only object of producing a more esthetic effect. But two questions arise in studying Mr. Strobel's design. First, in the design shown the upper curves of the stiffened truss are concave. What are the considerations that prompted the designer to make them so and not straight as the Fidler truss, or, still better, convex? The analysis of this type of trusses with only tension in both chords shows that both intersecting chords must have each one continuous curve, and in the limiting case, as in the Fidler truss, one half branches off in a tangent. But by making the upper portions of the curves concave a point of contraflexure is introduced and the continuity is broken. Besides, the stiffening braces between the chords will evidently get some additional stress due to the tendency of the upper chord to straighten when the left half of the bridge is only loaded and similarly for the left chord with the right half loaded. Especially will the concave form be troublesome for wire cables for erection purposes. While a wire can always be so arranged as to give when freely suspended a continuous convex curve of the form desired, it cannot produce two curves, one concave and one convex, with a point of contraflexure at the center. A second question arises with the downward deflection. How does the designer provide for downward deflection due to a live load on the bridge? While the stiffened truss has a hinge at the center and will readily respond to any deflection, the curved strut on top cannot deflect downwards, even if hinged at the center, and deflect it must. The esthetic appearance of the truss may also be questioned. The eye asks whether the small arched strut on top is strong enough to hold up the stiffened trusses together with the floor and its load, as such is the impression of its functions on the eye of the layman.

You will probably already have noticed the mistake caused by interchanging in the article in question Figs. 1 and 2 and their respective tables. Yours truly,

Leon S. Moisseiff.

New York city, N. Y., July 29, 1897.

Sir: The article on "A New Truss-Design," by Mr. C. L. Strobel, in your issue of July 22, sets forth that it was intended for the Sixth Street bridge in Pittsburg, Pa., and that in 1890-91 competitive plans for the same had been invited from engineers, with a prize for the best design.

Having unintentionally had a part in that competition, I beg leave to make a correction regarding the facts in the case. In 1890 I was consulted (without my seeking) by officials of the company owning that bridge regarding the contemplated changes in their wire-cable suspension bridge built by the elder Roebling in 1859. I advised an entirely new bridge, with changes in grade and alinement, and thereupon was asked to make plans for such bridge. The type I selected was the double-braced arch (Lohse system) in three spans, with stone tower entrances, the latter to be used also for offices.

While still working on the plans I was informed that a number of engineers and contractors were importuning the company for permission to submit plans; that the company had decided to let them do so, and that all plans, specifications, estimates, etc., should be submitted to a disinterested expert selected by the company, an arrangement to which I assented. The expert selected was Mr. Henry Flad of St. Louis, Past President, Am. Soc. of C. E. I did not specially inquire who the competitors were, and I did not know that Mr. Strobel was one of them until I read his article in Engineering News.

Mr. Flad made his report, and I was then informed that my plans had been adopted by the company as the best of those submitted, and I was requested to prepare the work for execution. From my correspondence on behalf of the company with the late Col. Merrill, then having charge of the Allegheny River, it became apparent that the War Department would require two spans, instead of the three which I proposed, and I therefore made the corresponding change in the plans. In the spring of 1891 I decided, for good and sufficient reasons, to dissolve my re-

lation with the company. My bill for plans and services was paid, and I had no further connection with the work. To the best of my knowledge, the company never had offered a prize for the best design to any one; contrary to Mr. Strobel's statement; and the so-called competition (in the trade vernacular) was the not unusual "scramble for a job" by a number of self-invited contractors and engineers, falling over each other to offer their services gratis.

The above explanation of the facts in the case is given with no intention of reflecting upon the design of Mr. Strobel, which I believe to have very substantial claims to merit; nor do I reflect personally or professionally upon Mr. Strobel, for whom I have a high regard. The final product of that so-called competition was not entirely satisfactory to the company, I believe; but it fittingly illustrated the public declaration of one of the older competing engineers that engineering is not a profession, but a trade, a declaration which, if perhaps lacking in loftiness or in ambitious inspiration to our young graduates, seems to have at least some support in everyday facts.

I do not feel called upon to enter upon a discussion of the respective merits of the double-arch (Lohse) type, as compared with other types, but will merely say, after careful consideration, that I do not agree with all of Mr. Strobel's views regarding it. The figures to the illustrations of Mr. Strobel's article, on page 51, were misplaced. Fig. 1 should be Fig. 2, and vice versa.

Gustav Lindenthal.

New York, Aug. 2, 1897.

Notes and Queries.

S. A. C., of Lexington, Ky., wishes references to legal decisions establishing the liability of companies distributing electric currents for damages to water mains caused by electrolysis.

THE FAILURE OF THE COMMERCIAL ATTEMPTS TO SUPPLY FUEL GAS IN THE UNITED STATES.*

By F. H. Shelton.

For the past ten years or more fuel gas has been dinned into our ears without end. It has been demanded, derided, debated, praised and damned. The public, educated by natural gas, has apparently asked for it; brainy gas men have written exhaustive papers to prove that it could be, and other brainy gas men have written other exhaustive papers to prove that it couldn't be. Quick-witted promoters have used it to sell plants and process "rights;" unscrupulous raiders have used it as a disguise in attacking existing illuminationg gas companies, and a few genuine and legitimate efforts have been made to sell fuel gas commercially, in the sincere but mistaken belief that it would prove a success. What is the net commercial result to-day, after 16 years' agitation and trial?

I propose to show that fuel gas as a whole in every case where tried has been a flat and total failure; and more specifically, that in every case where attempted it has been either:

(1) A cloak for strikes and raiding schemes against existing companies and invested capital; or (2), but a guise for the sale of rights for patent fuel gas processes, which processes,in every case, have failed of their purpose; or (3), where sincerely attempted, and free from taint as above, each genuine commercial fuel gas effort has been a total failure.

These are perhaps sweeping assertions. I am content to rely upon the record to bear me out. History is history, and facts are facts; and the facts of fuel gas history cannot be gainsaid.

I propose to first give you a brief account of all the instances where fuel gas has actually been made and distributed, in this country, in so far as I have been able to ascertain. I think you will find that no instance of any moment has been omitted.

What I am referring to is the record of the purely commercial side of the fuel gas question. That is, the results of the instances where a so-called cheap and non-luminous manufactured gas has been distributed to the public for general use as a so-called "fuel gas," to replace coal, or other combustibles used for heating, cooking, power and other purposes.

The population figures given herein (and the names of certain towns as to exact spelling) are from the census of 1890.

Yonkers, N. Y.—When the Lowe water gas process first became prominent, about 20 years ago, it gave a pronounced impetus to the consideration of the possibility of a gas that could be made so cheaply that it could be used for fuel purposes. The use of "blue gas" (the first step of the Lowe illuminating gas process) very naturally suggested itself. It and no other form of artificial gas seemed available. This gas was easily and cheaply made, and had a good—and as it was thought, a sufficient—heating value for the purpose. After considerable discussion, and the proposal of several forms of apparatus for its cheap production, a tangible commercial trial of it took place, in the shape of the first fuel gas venture in this country, as far as I have been able to ascertain. This was in Yonkers, N. Y.

The enterprise took shape there in 1880, the works being started in December of that year, by the "Yonkers Fuel Gas Company." The promoters were M. H. Strong, R. W. Van Pelt, H. Skinner and others. Van Pelt was President of the Strong Gas Fuel & Light Co., controlling the Strong and the Lowe processes for the State of New York, and the Yonkers Company, while said to be in many respects a genuine effort to sell fuel gas, was none the less a "show" plant to replace an experimental one, first erected in Mount Vernon, on which to sell patent rights. The capital stock was $185,000, the bonds $50,000. The plant is said to have cost about $125,000. The Strong apparatus, supposed to be an improvement over the Lowe, in general design was, to all intents and purposes, the double superheater setting of the Lowe apparatus of today, but built in a single rectangular shell, and excepting that: First, no oil appliances were involved and, second, during a "run" of gas-making either powdered anthracite coal or bituminous slack was fed into the top of the generator through a suitable hopper. The product was a blue water gas, of 310 to 365 heat units, or a rather richer gas than the ordinary Lowe "blue" gas. This gas was unpurified, and was sold for fuel only, at 50 cts. per 1,000, against the old company's price for illuminating (coal) gas of $2. No incandescent gas burner of any standing was then on the market.

The enterprise was a flat failure, although it had all the advantages of novelty, and was persisted in for two years, in one of the most thriving manufacturing and residential cities of 32,033 population in the country. The total number of customers secured was but 55. After selling about 30,000,000 ft. of fuel gas, trying illuminating (?) gas and a receiver, the franchise and plant were sold to the United Gas Improvement Co., at the time that that company bought and consolidated the various Yonkers gas properties.

No other "Strong" process plant has since been erected to my knowledge.

Lynn, Mass.—The next place to try to sell fuel gas was Lynn, Mass. (population 55,727). In this city a steam heating company (having also a franchise for gas), styled the "Citizens' Steam & Gas Light Co.," had built a steam distributing plant, which had been practically abandoned. Prof. T. S. C. Lowe, L. P. Lowe and others (five stockholders in all) bought it up, put in a water gas plant and commenced to distribute "fuel gas," Nov. 10, 1883. The capitalization was $125,000; bonds, $115,000 (assessor's local plant valuation was $20,000). The gas distributed was a plain, "blue" water gas, unpurified, of about 300 heat units. It was sold at 50 to 30 cts. per 1,000 under both contract and meter system, for power and heating purposes in the manufacturing district chiefly, through 4¼ miles of main, about half 6 and half 8-in.

The first send-off was quite successful. Within a few weeks an output was reached of 150,000 to 250,000 ft. daily; but this did not last long. Something was wrong. It dropped down to but a fraction of that, and no later effort galvanized the corpse. Among other faults, the unpurified gas gave off in burning a strong odor; the sulphur in the gas, in combustion, also formed sulphurous acid, and attacked the iron of stoves, the valves of gas engines, etc., and played havoc generally. Although purifiers were (after two years) finally put in, the fate of the scheme was doomed. The gas supplied didn't do the heating work expected, and the public wouldn't have it. The concern jogged along, until, after 5½ years of unprofitable existence, it gave up the ghost, in the early part of 1889. Small wonder, for by the report of the Massachusetts Board of Gas Commissioners, we find that, about 1887-88, for instance, for one fiscal year, the taxes paid, of $384.24, amounted to .0581 cts. per 1,000. This showed total yearly sales of but 6,613,000 ft. At 50 cts. per 1,000 this would mean the princely gross income of $3,306 per annum! The old company meanwhile, for three years, for instance, selling illuminating gas at $1.80 per 1,000, sold one year 38,400,000; the next year 42,452,300, a gain of 10½%; the next year 48,411,500, a gain of 14%. Which gas the public found the cheaper and preferred is obvious. The fuel gas plant was finally destroyed by fire, and the franchise and other junk assets were, I believe, ultimately bought in at sheriff's sale by the Lynn Gas Light Co. The principal promoter of this Lynn gas scheme said to the writer no later than February, 1897: "We had figured all along upon getting permission to change to illuminating gas."

Troy, N. Y.—The next fuel gas enterprise was in Troy, N. Y. (population 60,956), and it, in conception and results, was essentially a reproduction of the Lynn fizzle, only it didn't last so long. The "Troy Fuel Gas Co." was organized about December, 1885, and the works were started up about the middle of 1886. The plant was of the Lowe type, making the same blue gas, which was also sold at 50 cts. per 1,000, as at Lynn. It was capitalized at $300,000; bonds $100,000. It ran for about six months, a financia failure from the start. On Jan. 17, 1887, a street main broke and the odorless gas, traveling some distance under the frozen earth, entered the cellar of a house (that had no gas service), and before discovery suffocated a number of people, three of whom died. This tragedy led to the revoking of the franchise, and the whole was ultimately sold out to the old company for $32,000. It then appeared that the total sold had been but 6,905,[illegible] ft.; total income, $1,355; total expenses, $11,400! This Troy scheme was generally looked upon as a raid pure and simple upon the gas business of the city.

Bellevue, Ky.—The peaceful village of Bellevue, population anywhere from 3,000 to 10,000, across the river from Cincinnati, and which had never had gas of any sort before, was, as Gen. Hickenlooper expresses it, seized with the fuel gas fever about the summer of 1887, and a gas works, with a 6,000-ft. holder and one 8 × 10-ft. purifier, was built by the Bellevue Water & Fuel Gas Co. G. R. Harms, the controlling spirit, and later also Ohio and Kentucky agent for the Loomis process, had some knowledge of gas speculations, as may be noted from the fact that, though the plant was estimated as costing not over $15,000, it was stocked for $10,000, and bonded for $100,000 also. A "pitcher-spout" Springer cupola form of the Lowe process was installed, and a blue water gas made of about 300 heat units, similar to that at Lynn, Troy, etc. For light the Fahnehjelm comb was used. Gen. Hickenlooper is my authority for the statement that they started off with an output of about 3,000 ft. per day (income $1.50) to four consumers (three of whom were stockholders) and to six lamp posts, and that the scheme "petered out inside of six months." Certain it is that (by Brown's Directory) in 1889 they were selling (illuminating) gas at $1.25, and that they have done so ever since. Thus was this Kentucky experiment short-lived indeed.

Los Angeles, Cal.—From somewhat scant sources of information I gather that, about 1888, the "Lowe Gas & Electric Co." was formed in this city (50,395 population) for the supply of fuel gas, with the usual advertised advantages therefrom to accrue to the public, with T. S. C. Lowe, president (who had about that time removed to the Slope), and L. E. Mosher, secretary. As this gentleman is also recorded as treasurer of the "Consumers' Gas, Light, Heat & Power Co," formed to sell "Lowe" fuel water gas (Brown's Directory for 1887), it would appear that the project first contemplated in the Consumers' Company had materialized in the "Lowe" Company in question. The Lowe works was erected in 1888, starting out, I understand, with the delivery of the usual non-luminous blue gas, which basis lasted but a brief time, as, in February, 1888, I find they were delivering an illuminating gas in direct competition with the old Los Angeles Gas Co. (selling at $2.50), with all the accompaniments of a bitter gas war. The fight lasted until December, 1889, at which time the companies came together and reorganized as the "Los Angeles Lighting Co."

It is a good opinion that the fuel gas plea was but a means to the end of a "strike" upon the old company, and that it served its purpose. Of the Los Angeles project, Gen. Hickenlooper has said in that vigorous language that he can upon occasion use so well: "It was built, 'busted' and turned into a purely illuminating gas company, all within a period of about six months."

The present president of the Los Angeles Company confirms the fact of this fuel gas failure, in advising me that the effort to manufacture and distribute fuel gas was unsuccessful.

Omaha, Neb.—In 1887-88 the gas company at Omaha (population 140,452) was also raided, under the guise of fuel gas, by parties who had just built an illuminating works at Council Bluffs, across the river. The "Nebraska & Kansas Gas & Heating Co.," capital $500,000, bonds $300,000, secured a franchise calling for two sets of mains, fuel gas at 75 cts., and illuminating at $1.35. The old company's price then was $2 for illuminating water gas.

The newcomers secured Boyd's old packing house in the stock yards district for their plant, constructed two sets of Lowe apparatus of the Boeklen form from old lard vessels, put in a 15,000-ft. holder, a 10 × 10-ft. purifying box, and possibly 1½ miles of 6 and 4-in. mains. A good estimate puts their outlay at $35,000. The Boeklen apparatus consisted of a water gas generator working with a single superheater shell, the latter having, however, a vertical partition in it to form two chambers. There was no oil piping whatever in connection with it, and the product was a plain, blue water gas. The plant was run intermittently, and possibly a trifling amount of gas sold, but the enterprise never made headway. The backers had reckoned without their hosts. The newcomers failed to live up to their promises or representations. Eventually their franchise was revoked, and what had started out ostentatiously failed ignominiously.

Terre Haute, Ind.—In this city, of 30,217 population, the history of fuel gas failure has been repeated, and it is of interest because of the use of an oil gas in place of the usual blue water gas. The Citizens' Gas & Fuel Co. (capital $50,000) took shape in 1889, and about February, 1890, commenced the distributing of a "fuel gas" made by the "recent McKenzie" process. McKenzie, hailing from New York, was a chief promoter in the company, and local associates had bought the "rights" for Ohio, Indiana and Illinois. A show plant in Terre Haute was very convenient. In McKenzie's machine, "runs" are made of a mixture of steam, oil and air through a previously heated lined shell full of firebrick, similar to a water gas super-

*Abstract of a paper read before the annual meeting of the Western Gas Association at Cincinnati, May, 1897. The full paper, with a lengthy discussion, is given in the "American Gas Light Journal" for June 7.

heater. (The Archer, the Kendall, the Van Syckel, the Parker, etc., are all narrow variations of this plan of manufacture.) The resulting gas is very variable, closely depending upon the care exercised in valve manipulation. In Terre Haute no purifiers were used at first, but, trouble from their absence resulting, they were added later. The gas made so largely from oil, while largely nitrogen, had nevertheless a good heating value, say from 400 to 565 units, or about two-thirds that of the illuminating gas furnished by the old company. Its promoters, however, claimed it as equal to natnral gas. It was sold at 35 cts. as a fuel gas against the Terre Haute Co.'s mixed coal and water gas, of 26 c. p., at $1.25. The fuel gas scheme didn't go; "at the end of four or five months they had but 22 customers, 8 of whom were stockholders." A year and a half of this was enough, and they then, as usual, changed to the supplying of an illuminating gas (at 50 cts. per 1,000), abandoning the professions of fuel gas utterly. A bitter gas war ensued for five or six years, involving $50,000 more plant expenditures, finally ending in the consolidation of the opposing interests, on the usual lines of enlarged and unnecessary capital.

Tacony, Pa.—At this place, which is a manufacturing suburb of Philadelphia, with about 5,000 or 6,000 population, a plant for making fuel gas was erected, about 1888. Although by far intended primarily for the supply of a fuel gas for manufacturing purposes to the Disston Saw Works (by which interests erected and controlled), fuel gas has nevertheless, from the summer of 1889, been supplied by the "Tacony Fuel Gas Co." to such of the townspeople as would take it. It is, therefore, proper to note what commercial success has been attained in the public use of "fuel gas" at that point. The gas was made by the Loomis process (about that time rising to prominence), of the blue, or fuel, variety. By definite analysis a sample shows 307 heat units. While it has been sold at 50 cts., the general present rate seems to be 30 cts. In 1891 there were 25 public consumers. In June, 1896, there were but 12 such consumers, and the annual output to the public was then about 1,500,000, an average of about 4,100 ft. per day. After seven years' operation this cannot be said to be such a brilliant record of success as to give much comfort to the advocates of commercial fuel gas.

Akron, O.—The first commercial effort of moment, however, on fuel gas of the Loomis variety was made by the Akron Light, Heat & Power Co., organized about 1889, and starting up its works about May, 1890. The promoters and organizers, principally from out of town, were Burdett Loomis and others. The works (well built and capacious, and evidently designed by its projectors to be equal to supplying all the gas in Akron, should events shape that way), were said to have cost, with 7 or 8 miles of main, about $165,000. The capitalization was $200,000; bonds, $147,000. The Loomis producers were used, and the gas was purified by oxide of iron. It had a perceptible and sufficient odor, and was sold for fuel and for light, with Welsbach lights on a graded scale, at from 50 to 30 cts. per 1,000. The old company's price for coal gas was $1.40.

This Akron scheme lasted scarcely over a year. The gas was found to be not economical. The company reached a reported output of anywhere from 50,000 to 60,000 ft. to 125,000 ft. per day, maximum sendout, on some 250 to 300 consumers, but it could neither hold these customers nor get new ones, and it wound up by buying out the old illuminating gas company's works, and shutting down its own, although the latter was much the finer plant of the two. A much vaunted feature of the Akron fuel gas scheme was the supplying of producer gas to potteries, for kiln work, etc. The gas works were located within a few hundred feet of the pottery works, with that end in view. Trial was made, and the pottery business scheme proved a dismal failure, not only producing no income whatever for the fuel gas company, by working economically, but failing even to satisfactorily work at all.

The Akron case was a prominent and flat fuel gas failure. With a fine works in one of the best Ohio cities, having 27,601 population, aggressive management, against the "conservative" ditto of the old company, cheap coals, the Welsbach burner then available, the experience of other fuel gas efforts to go by, and other factors of success, it should, in a year's trial, have proved such "if it was in the wood;" but it was not. It proved to be the old, old story of the camel getting his head in the tent, under the plea of fuel gas, and winding up with his whole carcass inside (and the owner out) carrying on the old company's illuminating gas business, only.

Centerville, Ia.—The promoters of the Loomis process induced a good many people to believe in the alleged success of fuel gas, along about 1890 and 1891, and, still better, to buy works of them with all the patent rights attached. And so, in 1890, in Centerville, Ia., we find an instance of it in the gas company organized by John Hunt and local citizens, in this little town of 3,668 inhabitants, that had never known any kind of gas. It bravely started off under the caption of the "Centerville Light, Heat & Power Co.," to distribute fuel gas. The plant cost $20,000. It was stocked at $35,000. There were no bonds. The process was the Loomis, and the gas (similar to that made at Akron, Tacony, etc.), was sold for 90 cts. per 1,000 for light (with Welsbach lights) and 75 cts. for fuel. For one year, two years, three years did the company stick at it before giving it up. They had bought the "process" and they genuinely tried to get a return out of it. In all this time they secured but 100 customers all told, and sent out at their highest but 15,000 ft. per day. Numerous reasons entered into the failure; continued financial ones were the chief and sufficient. They turned to the making of regular illuminating gas, and have continued that ever since.

Rapid City, S. D.—Another case of local stockholders of a gas company (formed to supply gas in a town not previously having had gas) being led to believe that the supplying of fuel gas would be a profitable venture, occurred at Rapid City, S. D.; population, 2,128.

The company was the Rapid City Gas Co.; capital stock, $200,000; bonds, $60,000; organized about 1890. It put in a Loomis plant, and started out to deliver fuel gas with the use then of the Fahnehjelm burner, and later the Welsbach for lighting purposes. The details of price, extent of business, etc., I know not; nor are they especially material. In 1894 the property was sold to other interests and (in 1896-97) the present owners are arranging to drop fuel gas and substitute a standard illuminating gas. If fuel gas had been successful would this be contemplated?

Ottumwa, Ia.—Fuel gas was tried in this town once, and while it obviously was a failure from its having since been abandoned, I have been unable to get much detail of the circumstances.

The company was and is the Ottumwa Gas Light, Heat & Power Co.; capital, $100,000. A Loomis plant was put in, probably about the time that the Loomis plants were started in Centerville, Rapid City, etc., just mentioned, along about 1889 or 1890. There have evidently been two sets of mains in Ottumwa, for, about 1894 for instance, the output of fuel gas was 5,700,000 and of coal gas 4,500,000.

I understand that the former was served chiefly to the business district and the latter to the residential and outlying districts. Brown's Directory for 1894 reports prices in 1893; coal gas, 18 c. p., $2; fuel gas, $1. The latter was used for light with aid of the Fahnehjelm, and later the Welsbach burner, and was said to have had an odor given it by passing through a layer of foul lime in the purifiers.

In a letter, dated May 27, 1895, by a friend who had then visited the works, I am advised that the Loomis generator had been shut down "permanently," and that coal gas alone was being sold. Thus is the tally increased by one. The population of Ottumwa is 14,001.

Jackson, Mich.—The most conspicuously advertised fuel gas "success" in this country, and, therefore, the most conspicuous failure, at the time of its later collapse, was at Jackson, Mich. (population, 20,798), and the consideration of this place brings to our notice the first of several prominent efforts to make fuel gas go, upon what was known as the Evans-Fahnehjelm plan. The owners of the United States' patent rights for the Fahnehjelm incandescent gas burner, desiring to make a commercial demonstration of its merits, acquired, in 1887, the Jackson National Gas Light & Fuel Co. (capital, $50,000, at the start, and afterwards increased to $250,000), which had been a competing gas company to the existing illuminating company. They installed the "Evans process," which consisted of plain water gas generators, located in front of coal gas benches. Coal gas was made in the latter, and the hot coke raked into the former in which blue water gas was made. The two gases were led off and mixed, the water gas diluting the coal gas down to about (it is said) 400 heat units. The gas, purified by oxide, was first sold at $1, but shortly reduced to 50, 40 and 30 cts. The Fahnehjelm burner, used for light at a price of 3 cts., burning 5 ft. per hour, and with a life of 100 hours, increased the cost about 7 cts. per 1,000, and gave a bluish-white light of 20 to 22 c. p. They consisted of two rows of magnesia needles, about 1-20 in. diameter, suspended over the gas tip in such way as to become incandescent when in use.

In 1889, about a year and a-half after starting up, C. H. Evans, manager of the company, read a paper* before the Ohio Association, stating that the plant then represented some $150,000; that they had 11 miles of mains, 500 customers, 4,000 Fahnehjelm burners in use, and an output that had reached a daily maximum of 300,000. The prediction was made that "the general adoption of fuel gas was sure to come." The apex was reached of 1,000 customers and 400,000 daily output. Note now the outcome. First, the old coal gas company, which had been selling gas at $2, succumbed to the opposition, selling out its $200,000 plant to the newcomers for $65,000, leaving the latter in complete control of the city's gas supply, and later the supply of fuel gas was abandoned. No particular reasons were vouchsafed. Regular 21-c. p. illuminating gas was substituted, at a price of $1 and $1.25, and has been supplied ever since. In other words, fuel gas, after six years' persistent trial, failed, and the company, to protect its investment, reverted to the only artificial gas that has been found satisfactory for fuel alike, to both seller and user, viz.: A regular, high-heating power, high candle power illuminating gas.

*"American Gas Light Journal," April 8, 1889.

Chicago, Ill.—The owners of the Fahnehjelm patents, shortly after the Jackson enterprise, inaugurated in Chicago what has been by far the largest operation of fuel gas on a commerical scale in the country. The Mutual Fuel Gas Co., in 1889, bought up a gas franchise for the extensive and populous district of Hyde Park, and, with a capital of $500,000, spent close to that amount upon an extensive plant. Analyses of the gas distributed showed about 325 heat units, although 400 were claimed. The form of producing machine was new. The Fahnehjelm generator, so called, resembled a Springer water gas cupola, with the firebrick or superheating chamber considerably enlarged, to permit of also containing a vertical tapering retort in the center. Soft coal fed in at the top of this retort was carbonized by the heat of the surrounding superheater brick. The coal gas was duly led off. The coke descended by gravity to the generator, and was used for making water gas. The two gases, mixed and purified, formed the fuel gas. The whole construction was not unlike a self-feeding anthracite stove.

The start was made in the latter half of 1890, and operations were conducted upon a large scale. Fifty miles of main, 3,500 meters and innumerable Fahnehjelm burners were shortly put out; I am told that as many as 75,000 were used. One thousand stoves were given away to induce gas consumption. In 1891 a daily output of 900,000 was reported, which was later even doubled. In 1893 the annual output of 300,000,000 is given in Brown's Directory. The price was 50 cts. The old Chicago company's price for illuminating gas was $1.50.

What was the result of all of this also much advertised, ably pushed and especially extensive trial of fuel gas? Precisely the same as in smaller and all other instances—failure, pure and simple. The proposition simply did not pay, for the reason that, despite the volume of business at the low price necessary to induce the public to buy, fuel gas did not pay a profit to the company; and after three years, and a selling of 700,000,000 cu. ft., conclusive proof of this was shown by the change to illuminating gas to "protect the investment" and to get upon a paying basis. The company has since continued as one of the competing Chicago illuminating gas companies.

St. Joseph, Mo.—In 1890 the same Chicago interests that operated the fuel gas companies in Jackson, Mich., and Chicago, organized the St. Joseph (Mo.), Light & Fuel Co., in this city of 52,324 people. The capital stock was $250,000, and the bonds of $250,000 pretty well represented the cost of the plant, which was started up May 16, 1891. The Fahnehjelm producing apparatus was again used, making a blue gas of 400 (claimed) heat units, which (oxide purified) was sold at 50 cts. per 1,000, against the old company's price for illuminating gas, first, of $1.50, and later of $1. The Fahnehjelm comb was used for lighting purposes, and thus was a third extensive trial on Fahnehjelm lines under way. Although a business touching 700,000 ft. per day, and 900 customers, was worked up, the outcome was the same as preceding efforts. After two or three years of fuel gas operations, unsatisfactory to both the company and the public, the fuel gas was discarded, straight illuminating water gas was substituted, and a bitter warfare with the existing company started upon, which has continued from that date until the present, when the usual outcome happens, viz., consolidation and double the necessary capitalization, as shown by this extract from the "American Gas Light Journal," for April 19, 1897:

> The protracted gas war at St. Joseph, Mo., is said to be at an end. The settlement was effected through the purchase of the plants and franchises of the St. Joseph Gas & Manufacturing Company and the St. Joseph Light & Fuel Company by an Eastern syndicate, which will reincorporate under one management the properties named.

Cornwall, Ont.—Fuel gas was tried at this town, of some 8,000 population; and, as one more clear instance of failure upon Fahnehjelm lines, may be worth noting in this review.

The owners of the local gas company, previously operating upon a Lowe illuminating water gas basis, were induced to buy the Fahnehjelm incandescent gas burner rights and to supply fuel gas to the town, along about 1889, when the Fahnehjelm rights were first being exploited. They did so, no doubt, thinking it would be a successful enterprise, and for some time they distributed a blue water gas of about 300 heat units as a fuel gas. Experience taught the contrary; they abandoned it and reverted to illuminating water gas, with which they have continued ever since.

Fort Madison, Ia.—This place (population 7,901) was but a repetition of Cornwall. The owners of the Fort Madison Gas Co., becoming duly impressed with the much advertised and vaunted merits of the Fahnehjelm burner working upon fuel gas, about 1889 bought the "rights" for Fort Madison, ceased making the illuminating gas that they had been previously making in a Lowe or Granger water gas generator, and duly started in to deliver a blue, 300 heat unit, "fuel gas." Within a year we find them back to illuminating gas.

Grand Rapids, Mich.—There have been two nominal attempts to sell fuel gas in Grand Rapids (population 60,278), that at least reached the dignity of apparatus being

erected. They were perfect fizzles and almost unworthy of serious consideration. Yet they are so typical of the constantly cropping up instances of fuel gas schemes, in which the prime purpose is to sell stock and state rights, upon show plants of processes of dubious or indifferent worth, that I will recount their brief history.

The Michigan Fuel Co., a concern hailing from Chicago, struck Grand Rapids about June, 1891, and a year later started up a plant claimed to have cost $15,000. The capital stock was placed at the modest sum of $2,000,000. The process was the notorious "Hall" (an outgrowth of the "Proctor"), which so-called process, as you may know, has been exploited around the West for some years. The machine consists of a generator with adjacent chambers, through which air is blown, in a continuous process. Oil is added, and a little heat is used for propriety's sake, and the amount of "gas" made is in direct proportion to the speed and efficiency of the blower! Some steam is introduced which is decomposed at a temperature of 800 by the action of a "new (electric) chemical," opportunely invented by Miss Proctor. While standing (July 23, 1891) near the "electrode chamber" of one of these outfits, erected in Chicago, I was gravely cautioned to stand back, lest my watch should be affected. It goes without saying almost that the gas (a greased producer gas) was claimed to be "equal to natural gas" in heating effect, and the cost 2½ cts. per 1,000.

In Grand Rapids they located alongside the Grand Rapids Electric Light & Power Co., and fed gas to that company's boilers, their one customer and their landlord: "They were able to maintain steam after the pressure was once raised, provided no steam was taken from the boiler. This was hardly the result anticipated." Further trial did not change the results. They never distributed gas beyond the above. The plant was levied upon for rent. They had no ordinance and no mains.

About a year later, or in 1893, the next scheme came around. The "U. S. Heat & Power Co.," of Philadelphia, put in a claimed $7,000 plant of the Kitson process. The Kitson scheme contemplated the distribution of a cheaply made producer gas, of 150 or 160 heat units, in each city block from a small separate plant, say, in a basement in each block, thus working independently of boilers, street mains and franchises, a very simplifying and delightful proposition. A detail of the plan may be found in the "Journal of the Franklin Institute," for December, 1891, entitled "Fuel Gas," by Arthur Kitson.

In Grand Rapids they failed to run a 7-HP. gas engine, whether the fault of the engine or the gas I know not. Certain it is, the scheme made no headway. No gas was sold commercially, no customers were secured, all the local backers lost money, and the concern shut down. Three years later the Grand Rapids Gas Co. bought the $7,000 outfit for $200, probably to found a museum.

Maysville, Ky.—Probably the most flagrant exploitation of worthless gas patent or process rights, under the philanthropic guise of fuel gas, was that centering at Maysville (population, 5,358). A suave gentleman, of the name of W. H. Harris, arrived there along in 1890 or 1891, and showed wonderful power in interesting all hands in the "Harris" process. This was to revolutionize the business. Gas better than natural gas, at the trifling cost of 3 to 5 cts. per 1,000, was promised. People bit wonderfully. The Southern Fuel Gas Co. was first formed, also the local "Maysville Fuel Gas Co.," capital $25,000; bonds $15,000. The latter put in an exhibition plant and three miles of main. Washington (D. C.) people of prominence were also later interested; a show plant was put up there, and the American Fuel Gas Co. was formed, with $5,000,000 capital; also the Indiana Fuel Gas Co., with $5,000,000 capital; also the U. S. Fuel Gas Co., with $10,000,000. Harris' specialty was forming companies, and he truly was a master hand at it. Even farmers from all over that section of the Ohio valley bought stock, and literally a barrel of dollars was said to have been taken in. The process made a greased producer gas, having at least a third nitrogen, and with no intrinsic merit whatever; possibly 20 customers in Maysville took the gas made at the local plant at 40 cts. per 1,000. To shorten a long story, that reads almost like a fairy tale in its momentary success, the bubble duly burst. Harris was sought after by the police on that and other matters, and wound up in a sanitarium.

Boston, Mass.—Several bona fide efforts, however, entirely free from any taint of opposition company, or patent rights motives, have been made by gas companies to find out, by actual trial, whether the public would buy fuel gas, if afforded the opportunity. One of the first of these was in Boston (population 448,477). After more or less agitation, and apparent public demand for fuel gas, the Boston Gas Light Co. announced by circular and advertisement that, commencing Nov. 1, 1890, the public could buy all the fuel gas it wanted, at 60 cts. 1,000. The company had ample capital and talent, several miles of duplicate mains, plenty of producing plant, and the particularly intelligent community of Boston in which to operate and make a success of the much duscussed fuel gas problem. One thousand dollars worth of services in advance were put in, and gas was turned on into nine of the principal streets. After several months' operation it was totally discontinued, precisely one customer (and he a free one) having taken the gas. The whole cause of failure was through the common sense realization of the public that fuel gas at 60 cts. was no cheaper than the rich illuminating water gas sold at $1 for fuel purposes. The gas supplied was a purified, odorous Loomis blue gas, and had an advance advertised heat unit value of about 400. It would seem, therefore, as though the intention was to enrich the ordinary Loomis gas up to that figure.

St. Louis, Mo.—The incessant talk of fuel gas, and its alleged success, led the Laclede Gas Light Co., of St. Louis, to try a commercial demonstration of it, about May, 1890. The circumstances there also were especially propitious for success, the company having then recently acquired the disused, million dollar plant, with 20 miles of mains, of the defunct "Gas Fuel & Power Co." The enterprise further was directed by Mr. Emerson McMillin, one of the foremost of fuel gas advocates of that time, and was backed with the resources of one of the largest gas companies in the country. The gas was a straight Lowe water gas of about 300 heat units, as at Lynn and Troy, but purified, I think. It was sold first at 40 cts. Lack of response on the part of the public made the gas company offer the inducement of a 30-ct. rate. Yet, all told, only 60 or 80 customers were secured in this city of 451,770 people, and the highest daily output reached only 30,000 cu. ft. After six months the trial was entirely abandoned. It was a genuine effort to ascertain if a real demand for fuel gas existed, and to fill that demand if it did.

Des Moines, Ia.—About a year later a sincere, actual trial of fuel gas commercially was made by the United Gas Improvement Co. (with all that company's talent and resources to insure success), at its works in Des Moines, a city of 50,093 people. For local reasons a franchise was secured for the purpose, separate from that held by the existing Capital City Gas Light Co. for illuminating purposes.

Lowe water gas was distributed, enriched by varying quantities of oil per 1,000 for two purposes. (1) To make it safe by a distinctive odor; (2) to ascertain by actual trial just what grade of fuel gas was necessary to meet the demand. It was sold through large new mains, laid for the purpose, at 50 cts. per 1,000, against the illuminating gas at $1.70. Qualities ranging from 400 to 590 heat units were supplied during the six winter months of 1891-92. A total of about 20 customers only was secured. The maximum output was 100,000 ft. per day; the total 7,300,000. The attempt was finally abandoned, for the reasons that customers in general did not take hold in any number, and those who did, while finding it convenient, found that even the richest grade supplied cost them much more than coal for household heating purposes, and they one by one dropped out.

Of this trial of fuel gas commercially, one closely identified with it writes me as follows:

> We went into this thing for the purpose of determining in a practical way whether or not there was anything to be gained in the manufacture and distribution of fuel gas, at a time when so much was being said and written about the cheapness of fuel gas; and I believe the results of our experiments were satisfactory—in demonstrating that there was nothing in it except grief.

Savannah, Ga.—The United Gas Improvement Co. also commercially tried fuel gas in Savannah, Ga. In that southern city of 43,189 population, where not much, yet a little, fuel constantly at hand is frequently desirable, it would seem as though a fuel gas would be a public convenience and salable if anywhere. In 1890 the Mutual Gas Light Co. turned into a separate set of mains existing in the streets a "blue," Lowe water gas, lime purified and enriched by a gallon of oil or so per 1,000, to about 400 or 425 heat units, selling it at 50 cts. for fuel and at 90 cts. when the use of Welsbach lights was included for lighting purposes. Two years' trial, comprising all seasons, was given the matter, only again to end in abandonment. The greatest daily sendout reached was but 10,000 ft. and but 50 customers were secured all told.

Louisville, Ky.—This is still another place (population 161,129) in which the local gas company, to meet a claimed or supposed demand for fuel gas, supplied it for a time, only to find that the public would not subscribe to it when it was offered. The trial was made by the Louisville Gas Co. about 1891, with the plant and the 14 miles of mains of the defunct Citizens Gas Light Co. of that city. The gas at first distributed was a "blue," Lowe water gas, properly purified, of about 300 heat units, sold at 50 cts. per 1,000, against a price for illuminating gas of $1.35. No perecptible demand for it appearing, and the impression prevailing that perhaps it was because of an insufficient heating power, the quality was raised by the addition of oil to a 12 or 14-candle gas, making the heat unit value of course much higher. The result was unchanged. Engineer Barret speaks of the matter as follows: "During the entire trial my remembrance is that we obtained not more than three or four fuel gas customers. The customers' bills did not exceed $2.50 per month each. We gave the matter up in disgust."

Cottage City, Mass.—It may be said, however, that, despite all the foregoing, two fuel gas companies have been running for years and are still running, viz.: Cottage City and Framingham, Mass. Very true; but if their operation is construed as fuel gas success, the definition of success needs revision. The annual reports of the Massachusetts Board of Gas & Electric Light Commissioners fortunately give us sworn and detailed public figures of their operation.

Cottage City is a summer resort, on the island of Martha's Vineyard. Its residential winter population in 1890 was 1,080; in summer 20,000. In 1884, a gas and electric company was organized, a Loomis gas plant installed, and illuminating gas distributed. Capitalization, $90,000; bonds, $21,000. In December, 1888, it went into insolvency. After a year or so shut-down, it emerged, reorganized, with $25,000 capital and no bonds, and commenced distributing a non-luminous, Loomis fuel gas, at $1 per 1,000 for fuel and $2 net for light. (I suppose that in this latter rate the rental or use of incandescent burners is included.) These rates have continued since. The average actual rate return for gas sold last year was $1.56 per 1,000. It had, in 1891, and on fuel gas, 163 meters in use. After one year's time that number was increased to 181. Now, after five years more, it is but 199. Of these meters, 148 are 3-light and 43 are 5-light; 87 stoves and 2,530 Welsbach lights are reported. The gas made the first year of fuel gas was 2,696,000 cu. ft.; the second year, 3,468,000. Now, after 6 years of fuel gas operation, it is still but 3,412,500. The leakage has varied from 18 to 29%. Taxes have averaged about 5 cts. per 1,000. A small amount of oil has of late years been used, probably to increase the odor, for safety's sake.

From the Massachusetts reports in question, we learn that, after six years of operation, the volume of business is about where it was at the start. The original number of stockholders, 21, has shrunk to 10. Not an inch of main pipe extension has been made from the original 2.3 miles. The income barely meets expenses, and never in the history of the company has a dividend been earned or paid. It is difficult to see what induces the company to continue in operation.

Framingham, Mass.—The other instances of existing operating fuel gas, of which again we have detailed public figures, is that of the Framingham Gas, Fuel & Power Company, located at South Framingham, Mass., and supplying a population, variously given as from 6,000 to 10,000, and under conditions more normal than that of a summer resort. The company started January 13, 1891, with a capital of $75,000, and bonds of $75,000. The plant, a well-built one of rated capacity of 250,000 ft., comprised Loomis generators, the usual purifiers, holders, etc., and about 4½ miles of main. About two miles have been added since. It is locally assessed for tax purposes at $42,000. The company has been in operation six years. At the end of the first half year it had made 2,250,000 ft. of gas. The highest daily sendout was 28,000 ft.; the lowest 6,000. It had then 126 meters. The next year it made 8,250,000 of gas; 37,000 and 9,200 were the high and low daily sendouts, and meters were 191. For the year ending June 30, 1894, the company's greatest output was reached, viz.: 15,800,000 ft.; 68,000 and 16,000 were the highest and lowest daily outputs, respectively. Meters then were 267. In the last annual report, June 30, 1896, although the meters in use have increased to 286, the total gas made has declined to 13,900,000, and 57,000 and 14,000, respectively. The Loomis gas distributed has a claimed heat unit value of about 350. It is actually probably nearer 300. It is fairly odorous, and is purified. The first prices were 75 cts. net for light; 60 cts. for fuel. On these prices the average return steadily declined (doubtless as the proportion of fuel gas sold for heating vs. lighting increased) from 58 to 51, 49 and 48 cts. per 1,000, for the first four years, respectively. A new schedule, based upon quantity, not the nature of use, was then substituted, which has raised the average return to about 58 or 59 cts. per 1,000 feet of total gas sold. The taxes amount to 5 or 6 cts. per 1,000. Leakage has been normal. At present they have about 2,000 Welsbach lights in use. Seventy per cent. of the output was reported, in 1893-94, as being used for fuel purposes; 495 stoves are reported. So much for some details of their business. Now, as to financial success. In 6½ years of operation they have never paid a dividend. They have not paid more than a small fraction of the interest on their bonds. In their last annual report (June 30, 1896), $22,530 of interest due, but unpaid, is reported; also $23,332 of outstanding notes. The total liabilities, June 30, 1891, were $142,896. The total liabilities, June 30, 1896, were $197,784.

In the assets "patent rights and franchises" are valued at $40,000. Is any other conclusion possible than that a very nice plant, with similar construction profits, was unloaded upon the stockholders, with the privilege of afterwards operating upon fuel gas, profitably or otherwise, as circumstances might determine, and that the net result of six years' commercial business has been the cultivation, at a uniform and steady rate, of a debt of $49,119?

Bridgeport, Conn.—The last enterprise for the sale of fuel gas started in this country, one that is still operating, and one that is of especial interest as to its outcome, in view of its very considerable size, its favorable environment, and the fact that it has had all the experience of the past by which to profit, is in the city of Bridgeport, population 48,866. Bridgeport was the home of P. T. Barnum,

who gave utterance to an assertion in connection with circus freaks that is not inapplicable to "fuel gas" schemes, viz.: "The public likes to be humbugged."

The Citizens Gas Co. bought up an old floating franchise for fuel gas, along about 1894, and, after more or less delay and enlisting of New York capitalists, a plant costing close to $500,000 was constructed and put in operation August, 1896. Bonds to the amount of $500,000 were issued, likewise that amount of stock. Burdett Loomis was the principal promoter, and practically all his principal associates are non-residents.

The gas, of course, is the Loomis, purified by iron oxide, and of a claimed heat unit value of 350. Analyses by Dr. Love, of New York, show heat units of but 300. The company has been operating for eight or nine months, and according to its own claims, has reached a daily output of 400,000 to 500,000 cu. ft., sold to some 150 or 175 customers. The advertised price is 25 to 40 cts. per 1,000, but there is but little doubt that on some contracts with consumers of importance, a price as low as 12½ or 15 cts. has been made. The old company's price for illuminating gas is $1.25. In order to reinforce the odor for safety's sake, a chemical (mercaptan) and also a little oil have respectively and at various times been used. So much for some facts and figures; now as to results. Much effort has been made in Bridgeport to make fuel gas do the work claimed for it, and to satisfy its users. Energy, time and considerable expense have been put in by the gas company in experiments, constructing, furnaces, etc. The detail of this need not be gone into. Again has fuel gas not been a success, and by the testimony of Burdett Loomis, the principal promoter, who stated in a public legislative hearing that they were losing money, and who, on behalf of the company, was there petitioning the Legislature for an amendment to their franchise to permit them to make illuminating gas (petition refused).

Granting such permission would put their half million dollar works in full fledged opposition to the present illuminating gas company. Thus even again, and in the short space of but eight months—is the old promoter's plea of fuel-gas-because-the-public-wants-it—reshaping into an almost certain competition and then consolidation with the old company on an illuminating gas basis, with a probable trebled capitalization on which the public as usual will have to "pay the freight."

Summary.—The above is the record of practically all the enterprises to distribute fuel gas commercially that have taken shape in the United States. Let us summarize.

In 16 years, from Yonkers in 1880 to Bridgeport in 1896, 27 trials have been made. Of these 22 have utterly collapsed, and of the other 5, two (Bridgeport and Rapid City) are trying to get out of the fuel gas business, and three (Framingham, Cottage City and Tacony), after 6 years' operation each, now show less output or fewer customers than before, and never a dollar of earnings returned to stockholders from commercial fuel gas sales.

Of the 27 trials, 5 (Boston, St. Louis, Des Moines, Savannah and Louisville) were experiments by the regular illuminating gas companies, leaving 22 undertakings by new companies. Fourteen of these 22 were in cities already served with illuminating gas; and although the promoters would, of course, never admit it, it is nevertheless good opinion, by those particularly qualified to know, that most of these 14—or 10 to be specific—while ostensibly fuel gas projects, were in reality raids upon the existing gas companies, with the object of either securing part of their business or being bought off.

The fact was never lost sight of that at the proper time a small outlay would convert the fuel gas works into a full blown illuminating city gas works. History records that 6 of these 10 were successful, a consolidation of the competing interests finally occurring, with the usual additional and unnecessary capitalization resulting. Even so, however, the opportunity none the less existed and was utilized in each of these cases for finding out just what degree of commercial success attached to the fuel gas proposition.

Out of the 22 new fuel gas companies started—and disregarding for the moment the motive of organization—14 have either changed to illuminating gas or want to. Framingham, Cottage City and Tacony are fiascos, as far as commercial success goes, and the balance are totally out of existence.

Of the 22 efforts herein described, 14 can be said to be genuine attempts to meet an apparent demand for fuel gas, being in the main free from any taint of ulterior or patent right motive, viz.: Boston, St. Louis, Savannah, Des Moines, Louisville, Framingham, Bellevue, Rapid City, Cornwall, Cottage City, Ottumwa, Centerville, Tacony and Fort Madison. Of these attemps all have been abandoned, excepting Cottage City, Framingham and Tacony; the first two of which I have already commented upon, and the last of which, as explained, is but a side issue to a factory plant.

Of the fuel gas efforts noted, four (Framingham, Bellevue, Rapid City and Centerville) were in towns never having had other gas, thus preventing the comparison by the citizens of the heating value of fuel versus illuminating gas. This factor of advantage, however, made no difference in the ultimate result.

Bearing in mind that Rapid City and Bridgeport are trying to, and probably will, get out of fuel gas, and that Tacony is not a city plant as ordinarily understood, practically the only companies in the business to-day, so to speak, are Framingham and Cottage City. This, then, makes these figures of interest.

There are about 951 gas companies in the United States. The two yet sticking to fuel gas constitute but 1-475th part of the gas companies in the country. The total population served by United States companies is about 23,000,000. That portion served with fuel gas does not equal 0.1% of it. The total gas output in the country is reckoned at 60,000,000,000 ft. annually. The fuel gas delivered is less than 20,000,000, or less than 1-3,000th part of the whole. The capital invested in the gas business of the country is computed to be about $450,000,000. The fuel gas portion of it does not exceed $100,000, or 1-4,500th of the whole. In other words, after 16 years' trial of fuel gas, and nearly a score and a-half of efforts, the volume of business and the proportion of gas capital invested in the fuel gas end of the gas industry, are microscopical—infinitesimal, almost.

If fuel gas could be made and sold at a profit, satisfactorily alike to both the public and the sellers, would the showing be as above? If Framingham is a success, why is it not repeated? There are towns a plenty. If Bridgeport is a success, why is it petitioning to be allowed to make illuminating gas? If such interests as the United Gas Improvement Co., the Boston Gas Light Co., the St. Louis gas people and others were unable to solve the problem, is there likelihood of others succeeding, with no essential change in the condition?

If the able former promoters of the Fahnehjelm interests, who in their Chicago works alone sold more fuel gas than all the others who have tried it put together, have, after six years' trial at three points, given it up, what warrant is there for assuming success by others, with no new process or facts of any moment whatever upon which to predict a different outcome?

The hard fact at present is that the most intelligent minds, the most scientific engineers, and the best business managers in the gas business of the country have tried to make a success of fuel gas, and have given it up for the present, or under present conditions. The records show that, since the numerous trials around 1890 and 1891, and the latter respective failure of the same, no new fuel gas projects have been started, excepting the Bridgeport Co.; and that company before a year's time has rolled around is already asking to sell illuminating gas in opposition to the old company, and thereby raising a world of question as to its original motive.

It is idle to prolong the wake over a corpse. In 15 States, from New England to California, from Canada to Savannah, in the largest of cities and the smallest of towns, under favorable conditions of one sort, and under favorable conditions of another sort, with prices of all sorts, and with processes of all sorts, and backed by the zeal of enthusiasts or the greed of promoters, fuel gas has been tried, and with this result:

As a vehicle for raiding existing illuminating gas companies it is apparently literally an "everlasting good thing," for its use for that purpose is far from done with. For the exploitation of worthless process rights, it is better than gold bricks or green goods; but as something to which the public will subscribe, even though offered repeated opportunities, or as something that will pay business men to undertake, commercial fuel gas so far has been an unqualified, unmitigated, complete failure. Why?

One great, main reason has been a universal cause of failure, in comparison with which other factors have been but incidental. That reason is this:

Heat in gas form has not as a whole been sold any cheaper in the shape of "fuel gas" than already sold in the shape of illuminating gas and, therefore, the public has been no better off.

A heat unit is that intangible, yet definite, conceivable quantity of heat that will raise the temperature of a pound of water one degree Fahrenheit. A gas that by chemical analysis of its constitutents is found to have a value of 650 heat units, is twice as "strong" (so to speak) in heating value as one in which an analysis shows constituents of but 325 heat units. The public, in practically every town and city in the Union, already is served with illuminating gases, perfectly available for fuel, ranging from 625 to 750 heat units in value, such gases being sold according to various local conditions at from $1 to $2 per 1,000.

The "fuel gases" offered, while apparently cheaper, being sold at 30 to 90 cts. per 1,000 as a rule, have had a range of heating value, however, of but 300 to 400 heat units. Of what economy and advantage are such then, if offered at half the price of illuminating gas, if they average but half as good? As numerous trials above recorded show, the public use it at the first send-off of a new and muchly advertised enterprise, but experience soon shows the facts and customers drop out, preferring illuminating gas, which not only has a quicker heating effect, but the added convenience of giving light from the same set of pipes without the intervention of special burners. An additional reason of ultimate failure (as the record shows) is that no fuel gas company, selling fuel gas at prices necessary to make the public buy it, has ever paid expenses or a profit. This is because while its selling price is cut in half compared with city gas, the expense of operation is not. The gas may cost a little less to make, but it costs as much to distribute, and the works, holders, mains, services, meters, etc., must be larger than those necessary to deliver an equal supply of heat in the same time by illuminating gas. The investment per 1,000 sold becomes excessive. For instance, the Bridgeport fuel gas plant has, I am told, 20, 24 and 30-in. piping around the works. A plant for illuminating gas in Boston, St. Louis, Baltimore, etc., cities of several times the size, would have no larger mains. The tendency towards bad accidents, because of the relatively less obvious odor compared with illuminating gas, has also been a handicap not to be overlooked. The failure of fuel gas has not been because of any particular process employed, as against another, whether Lowe, Loomis, Fahnehjelm or other. None of these processes supplies a gas with a high enough heating value to often equal or even surpass the average illuminating gas as a heating agent, at an average of twice the price.

In 16 years the gas interests have not discovered how to make better fuel gas than has been tried, and until some method is discovered of making a non-illuminating "fuel gas" of say twice the heating value of the fuel gas of the past, so that it will compare with existing illuminating gases in heating value, fuel gas will continue to be a failure.

SMOKE ABATEMENT ORDINANCES.

The Board of Health of the city of Philadelphia recently requested the Franklin Institute to investigate the question of smoke prevention, and to offer practical suggestions relating thereto. As a result of the request two stated meetings of the Institute were devoted to a discussion of the smoke problem. The discussion was participated in by many well-known engineers, and letters on the subject were contributed by others who were unable to be present. The full discussion and correspondence are printed in the "Journal" of the Institute for June and July, covering 65 pages. At the close of the discussion a set of resolutions was presented and referred to the Board of Managers for action, two clauses of which are as follows:

Whereas, It appears from testimony of scientists and expert mechanics, presented at this meeting by invitation of this Institute, that it is practicable to burn bituminous coal in stationary boilers and furnaces without creating a smoke nuisance.

Therefore be it resolved, that it is the sense of this meeting that the continuous or frequent discharge of dense black smoke from the combustion of bituminous coal is unnecessary, and should not be permitted within the city limits.

The Board of Managers, at its stated meeting on June 9, passed the following resolutions:

Resolved, that in view of the importance of the subject and the necessity of having any deliverance by the Franklin Institute carefully considered, the Board of Managers recommend that formal action be deferred until every member of the Institute shall have had the opportunity of reading the discussion as it will appear in the "Journal."

Resolved, that the Board will present resolutions covering the subject, with its recommendations, to an early meeting of the Institute.

The discussion, as printed in the "Journal," includes opinions on all sides of the subject of smoke prevention, and is worth reading by any one who is called upon to study the problem, but for the most part it is, as was expressed by one member, a "threshing of old straw." An appendix to the discussion, however, contains a compilation of various city ordinances regarding smoke prevention, and it should be of value to those who may have anything to do with framing similar ordinances for other cities. We give below some condensed abstracts from these ordinances, omitting much of their legal verbiage:

Pittsburg.

Sec. 1. On and after Oct. 1, 1895, the emission of more than 20% of black or dark gray smoke from any chimney where bituminous coal is used as fuel in connection with boilers for heating and power purposes shall be deemed a public nuisance.

Sec. 2. That it shall be unlawful for any corporation, copartnership or individual using any chimney in connection with boilers within the city limits, as provided in Sec. 1, to allow smoke from bituminous coal to be emitted therefrom.

Sec. 3. Any corporation, etc., who shall allow smoke from bituminous coal to be emitted from any chimney used in connection with boilers for over three minutes duration at any one time shall, in addition to any and all laws requiring the abatement of nuisances, forfeit and pay to the city of Pittsburg for every such offence a sum not less than $10.

In discussing this Pittsburg ordinance Mr. T. P. Roberts, of Pittsburg, said:

This ordinance is almost as smoky and obscure as the

subject to which it relates. Sections 1, 2 and 3 conflict with themselves, and altogether it is so illy constructed that it may be doubtful whether there could be any successful prosecutions under its terms. The councils of no manufacturing city would be wise in entering too boldly upon such a field as this. If the edict reads "Let there be no smoke," at least practicable means should be pointed out how to maintain fires without its production. The lack of precision and general weakness of the ordinance may, after all, have been for the best. There has never been a desire to employ unduly oppressive measures against offenders in Pittsburg, and it has rather been the policy of the Department of Public Works, which has the enforcement of the ordinance in charge, to be as lenient as possible, and, through educational works and experiments at the pumping stations, to demonstrate that fuel bills might be reduced by proper methods of smoke consumption. Thus it is just now that Pittsburg is a permanent exposition of smoke-consuming devices.

After two years' experience ,a disposition has at last been manifested to take further and rather more stringent steps in the direction of a more decided reform. It is felt, however ,that state legislation is necessary before any decided movement is inaugurated; but in what way state laws are to be invoked I am not at present informed.

Chicago.

The emission of dense smoke anywhere within the city is hereby declared to be a public nuisance, provided that chimneys of buildings used exclusively for private residences shall not be deemed within the provision of this ordinance.

The owner or owners of any boat or locomotive engine, and the person or persons employed as engineer or otherwise in the working of the engine or engines in said boat or in operating such locomotive, and the proprietor, lessee or occupant of any building, who shall permit or allow dense smoke to issue or be emitted from the smokestack of any such boat or locomotive, or the chimney of any building within the corporate limits shall be deemed and held guilty of creating a nuisance, and shall for every such offense be fined in a sum not less than $5 nor more than $50.

It shall be the duty of the Commissioner of health and the Superintendent of Police to cause this article to be enforced, and to make complaint against and cause to be prosecuted all persons violating the same.

The Cincinnati ordinance is practically the same as that of Chicago.

Cleveland, O.

The emission of dense smoke from any chimney anywhere in the city, or from the smokestack of any boat, locomotive or stationary engine or boiler, within the limits of the city of Cleveland, shall be deemed and is hereby declared to be a public nuisance.

The owner, lessee, engineer, fireman, or other person or employe, having charge or control of or operating any boat, locomotive or stationary engine or boiler, manufactory, building or premises, within the corporate limits of said city, who shall permit or cause dense smoke to issue from any smokestack or chimney thereof, or connected therewith, shall be deemed and held guilty of creating a public nuisance, and upon conviction thereof in the police court of said city shall be fined not less than $50 nor more than $100 for each and every such offense.

It shall be the duty of the health officer of the Department of Police to enforce the provisions of this ordinance, and he shall, upon his own motion, or upon the complaint or information of any resident of said city, commence proceedings in the police court against any person for violating any of its provisions whenever, in the judgment of said health officer, facts warrant such proceedings.

The words "owner," "lessee" and "person" occurring in this ordinance in the singular number shall include the plural, and they shall each be construed so as to embrace corporations or partnership associations, as well as natural persons.

Ohio State Ordinance.

Every steam boiler furnace used within the corporate limits of any city of the first grade of the first class shall be so constructed, or altered, or have attached thereto such efficient smoke preventives as to produce the most perfect combustion of fuel or other material from which smoke results, so as to prevent the production and emission of smoke therefrom so far as the same is possible. And any person who shall use or allow the use of any such steam boiler furnace which shall not be so constructed or altered, or shall fail to keep such steam-boiler furnace for the prevention of smoke and such smoke preventives in good and efficient order and operation, shall be subject to a fine of not less than $20 nor more than $50 for the first offense, and for each subsequent offense shall be fined not less than $50 nor more than $100. And no steam-boiler furnace shall hereafter be constructed in any city of the first grade of the first class, except in accordance with the requirements of this section, under the penalty of $50 for each offense.

Every person having charge of the igniting, making, stoking, feeding or attending any such furnace, and any smoke preventives attached thereto in good and efficient order and use, shall see that the least possible smoke shall be produced and emitted therefrom, and any such person who shall fail or neglect shall be subject to the payment of a penalty of not less than $20 nor more than $50 for the first offense, and not less than $50 nor more than $100 for each subsequent offense.

St. Louis, Mo., 1893.

The emission into the open air of dense black or thick grey smoke within the corporate limits of the city of St. Louis is hereby declared to be a nuisance. The owners, occupants, managers or agents of any establishment, locomotives or premises from which dense black or thick grey smoke is emitted or discharged shall be guilty of a misdemeanor, and upon conviction thereof shall pay a fine of not less than $10 nor more than $50. And each and every day wherein such smoke shall be emitted shall constitute a separate offense. Approved Feb. 17, 1893.

Detroit, Mich., 1895.

The emission from any chimney or smokestack within the city of dense smoke, or smoke containing soot or other substance in sufficient quantities to permit the deposit of soot or other substance on any surface within the corporate limits of the city, shall be deemed and is hereby declared a public nuisance.

Sec. 2. Any owner, agent, lessee, manager of any building, boat, locomotive or other structure in the city of Detroit, who shall cause or permit dense smoke, or smoke containing soot or other substance as above, to be emitted from such structure, or from any other place which said soot or other substance shall damage the property or injure the health of any person, or shall especially annoy the public, shall, on complaint of any person so damaged or injured as aforesaid, or on complaint of any citizen or officer of the city in case of special annoyance, be liable for each and every such offense to a fine of not less than $10 nor more than $100, or to imprisonment in the House of Correction not less than 10 days nor more than 30 days, or both such fine and imprisonment, in the discretion of the court: Provided, that the provision of this ordinance shall not apply to buildings used exclusively for private residence or to steamboats.

Milwaukee, Wis. 1896.

The emission of dense smoke from the smokestack of any boat or locomotive, or smokestack, anywhere within the limits of the city of Milwaukee is hereby declared to be a nuisance: Provided, that chimneys of buildings used exclusively for private residences shall not be deemed within the provisions of this ordinance.

The owner who shall permit or allow dense smoke to issue from any chimney or smokestack within the said limits shall for every such offense be fined not less than $5 nor more than $50, or punished by imprisonment in the House of Correction for not more than 60 days. Every day which said nuisance shall continue shall be deemed a separate offense.

Hereafter, before approving plans and specifications for the erection of any business building or factory within the limits aforesaid, it shall be the duty of the inspector of buildings of the city of Milwaukee to see that proper provision is made in said plans and specifications to prevent the emission of dense smoke from the chimney of said building.

It shall be the duty of the Commissioner of Health and the Chief of Police to cause Section 2 of this ordinance to be enforced, and to cause complaint to be made against all persons violating the same.

Philadelphia, Pa.

Copy of ordinance submitted to Councils Jan. 1, 1894. (Never acted upon.)

Sec. 1. The Select and Common Councils of the City of Philadelphia do ordain that the firing and running of locomotive engines, or the firing of stationary or portable boilers emitting dense smoke, the result of imperfect combustion of soft or bituminous coal, anywhere within the incorporated city, shall be deemed and is hereby declared a public nuisance.

Sec. 2. The owner or owners of any locomotive engine, or stationary or portable boiler, and the person or persons employed as engineer or otherwise in operating such a locomotive or stationary or portable boiler, who shall permit and allow dense smoke to issue from the smokestack of any such locomotive or stationary or portable boiler, within the corporate limits, shall for each offense be liable to a penalty of $50.

Sec. 3. It shall be the duty of the Director of the Department of Public Safety to enforce the provisions of the ordinance, and to make complaint and cause to be prosecuted all persons violating the same.

Minneapolis, Minn. 1895.

Sec. 2. The owner or owners of any locomotive engine, and the general manager, superintendent, yardmaster or other officer of any railroad company having charge or control of the operation of any locomotive engine, and the person or persons employed as engineer or fireman in operating such locomotive engine, who shall cause, permit or allow dense smoke to issue or be emitted from the smokestack of any such locomotive engine within the city of Minneapolis, shall be deemed and held guilty of creating a public nuisance and of violating the provisions of this ordinance.

Sec. 3. The owner or occupant of any building, and the fireman, engineer or any other person having charge or control of any furnace or stationary engine who shall cause, permit or allow dense smoke to issue or be emitted from the smokestack or chimney connected with any such furnace or stationary engine within the city of Minneapolis, shall be deemed and held guilty of creating a public nuisance and of violating the provisions of this ordinance.

Sec. 4. Any person or persons violating the provisions of this ordinance shall, upon conviction thereof before the Municipal Court of said city, for every such offense be punished by a fine not exceeding $100, and may be imprisoned until such fine is paid, not exceeding 90 days.

THE RAILWAYS OF ILLINOIS, according to the report of the State Board of Railroad and Warehouse Commissioners for the year ending June 30, 1896, aggregated 10,544 miles, with 15,024 miles of track. This gives 19.02 miles of road per 100 sq. miles and 36.4 miles per 10,000 inhabitants. This state is said to have a greater railway mileage than any other state. The total capital is $2,069,164,142, or $67,556 per mile. The capital stock is 45.55% of the total capital; the funded debt 50.83%, and the current liabilities 3.62%. The operating expenses were 63.11% of the income from operation, and were distributed as follows: Maintenance of way and structures, 20.32%; maintenance of equipment, 14.74%; conducting transportation, 59.78%; general expenses, 5.16%. The passenger statistics show an average journey of 24.59 miles and an average revenue per mile of 2.365 cts. per passenger. The freight statistics show an average haul of 116.59 miles and an average revenue per mile of 1,232 cts. per ton. The total number of railway employees in the state was 72,246, with salaries aggregating $40,762,247. There are 2,740 stations, 4,681 bridges (of which 1,880 are of wood), aggregating 321,084 feet; and 17,727 trestles, aggregating 645,430 ft. Highway grade crossings number 11,401. There are 128 interlocking plants at railway grade crossings and junctions (3 not approved by the Commission), with 3,075 working levers. The accident record shows 595 persons killed (21 passengers and 173 employees), and 1,980 persons injured (104 passengers and 1,399 employees). Of the employees killed and injured 8% were killed and 34% injured while coupling or uncoupling.

THE PROPOSED CHINESE RAILWAY, from Hankow, on the Yangtse River, to Pao-ting-fu, has been made the subject of an examination by Col. W. W. Rich, M. Am. Soc. C. E., who has recently made a reconnaissance for the Imperial government, a proposition to build this line having been made to the government by a Belgian syndicate, though press reports now state that the syndicate has withdrawn its proposal. The distance is about 650 miles. A portion of the country is rolling, hilly and mountainous, but the greater part is a highly cultivated plain, dotted with many small groves, resembling very much the best of American prairie regions. Along the route there are many large and turbulent rivers, the crossing of which will require a considerable expenditure of money. The matter is now under consideration by Sheng Tajen, Director General of the Chinese Imperial Railways, but all arrangements for the construction of new railways in China are in a very unsettled state, except the work actually completed and in progress under the direction of Mr. C. W. Kinder, M. Am. Soc. C. E., Chief Engineer and Superintendent of the Chinese Imperial Railways. Having completed a first-class double-track railway from Tientsin to Pekin, Mr. Kinder is now building a line from Pekin to Pao-ting-fu, which is the capital of the Province of Chih-li, about 85 or 90 miles southwest from Pekin, and which is the starting point for the proposed line to Hankow, above noted.

OIL FUEL FOR LOCOMOTIVES is being tried as an experiment by the Wabash R. R., but it is too soon as yet to state results. Mr. J. B. Barnes, Superintendent of Motive Power and Machinery, states that two engines have been equipped for burning oil, one having the Prescott burner and the other a temporary contrivance which is under trial. The Southern Pacific Ry. had six or eight oil-burning locomotives on the Los Angeles division, but in consequence of a rapid rise in the price of the oil obtained near Los Angeles the supply to the railway fell short and some of the engines were converted to coal burners, which change can very easily be made. The Zerbe system of using oil for fuel has recently been tried on the New York elevated railway, but according to a published statement from Mr. Fransioli, the General Manager of the road, the system has proved a failure.

THE HOLLAND SUBMARINE BOAT, built at the Nixon shipyard, in Elizabeth, N. J., is reported as requiring some alterations in the machinery before a fuller test of its powers can be made. The private test has been postponed until these can be made.